

**EVALUATION OF PERFUSION INDEX BY MASIMO SET  
PULSE OXIMETRY TO PREDICT THE EFFICIENCY OF  
ULTRA SOUND GUIDED SUPRACLAVICULAR BLOCK IN  
PATIENTS UNDERGOING UPPER LIMB ORTHOPEDIC  
SURGERY**

*Thesis*

*Submitted for Partial Fulfillment of M.D in Anesthesia and Critical care*

*By*

**Amr Abd El Nasser Mahrous**

**(M.B., B.Ch)**

*Faculty of Medicine, Cairo University.*

*Supervised by*

**Prof. Dr Ashraf Rady Ahmed Aswa**

*Professor of Anesthesia, Critical Care and Pain Management.*

*Faculty of Medicine, Cairo University.*

**Lecture. Dr. Ahmed El Sonbaty**

*Lecture of Anesthesia, Critical Care and Pain Management.*

*Faculty of Medicine, Cairo University.*

**Lecture. Dr. Bassant Abdelhamed**

*Professor of Cardiology*

*Faculty of Medicine, Cairo University.*

**Faculty of Medicine - Cairo University.**

**2016**



## Acknowledgement

*All praise be to **Allah** and all thanks. He has guided and enabled me by His mercy to fulfill this thesis, which I hope to be beneficial for people*

*I would like to express my deepest gratitude and sincere appreciation to **Prof. Dr. Ashraf Rady**, Professor of Anesthesia and Intensive Care, Faculty of Medicine, Cairo University for his continuous encouragement, his kind support and appreciated suggestions that guided me to accomplish this work.*

*I am also grateful to Lecture **Dr. Ahmed Elsonbaty** Lecture of Anesthesia and Intensive Care, Faculty of Medicine, Cairo University who freely gave his time, effort and experience along with continuous guidance throughout this work.*

*I would like to express my deepest gratitude and sincere appreciation to Lecture **Dr. Bassant Abd Elhamed**, Lecture of Anesthesia and Intensive Care, Faculty of Medicine, Cairo University for her continuous encouragement, her kind support and appreciated suggestions that guided me to accomplish this work.*

*All the love and appreciation to all my Family members especially my dear Parents who were always supporting and encouraging me*

*Amr A. Elnasser*

## Abstract

The relationship of the pulsatile to the non-pulsatile amounts of blood at any particular site corresponds to PI at that site seventy patients scheduled for elective upper limb orthopedic surgery with ultrasound guided supraclavicular block and will be measure the average change in perfusion index by Masimo SET pulse oximetry (Masimo Corporation 40 Parker Irvine, California). At baseline and 10, 20,30min from administration of the block in blocked limb and contralateral unblocked limb.

Keywords

MAP-HR- PACU- ARDS-NIBP

# *List of Contents*

	Page
List of abbreviations	I
List of tables	III
List of Figures	IV
Introductions	1
Aim of the Work	3
Review of Literature	
Chapter (1): <ul style="list-style-type: none"><li>• Sonoanatomy</li></ul>	4
Chapter (2): <ul style="list-style-type: none"><li>• Pharmacology of local anesthetic:</li></ul>	24
Chapter (3): <ul style="list-style-type: none"><li>• Ultrasound guidance in regional anesthesia</li></ul>	40
Chapter (4): <ul style="list-style-type: none"><li>• Perfusion Index AND SET technology</li></ul>	54
Patients And Methods	58
Results	66
Discussion	72
Summary	78
References	81
Arabic summary	

## *List of Abbreviations*

AC	: alternating current
ASA	: American Society of Anesthesiologist's
ARDS	Average drug reactions
ASM	Anterior scalene muscle
BMI	Body mass index
BPL	Brachial plexus
BT	Bleeding time
CA	Carotid artery
CBC	Complete blood picture
CL	Clearance
CNS	Central nervous system
CPO	Conventional pulse oximeter
CT	Clotting time
DC	Direct current
DSA	Dorsal scapular artery
DST	Discrete saturation transform
ECG	electrocardiogram
HR	heart rate
IJV	internal jugular vein
LA	local anaesthesia
LMWH	low molecular weight heparin
MAP	mean arterial blood pressure
MSM	middle scalene muscle
NIBP	noninvasive blood pressure
PABA	para amino benzoic acid
PACU	Post anesthesia care unit
PC	Prothrombin concentration

<b>PI</b>	<b>Perfusion index</b>
<b>PN</b>	<b>Phrenic nerve</b>
<b>PT</b>	<b>Prothrombin time</b>
<b>PTT</b>	<b>Partial thromboplastin time</b>
<b>SA</b>	<b>Subclavian artery</b>
<b>SAO<sub>2</sub></b>	<b>Arterial oxygen saturation</b>
<b>SD</b>	<b>Standard deviation</b>
<b>TCA</b>	<b>Transverse cervical artery</b>
<b>TRI</b>	<b>Transient radial irritation</b>
<b>VDSS</b>	<b>Steady state of volume of distribution</b>

## *List of Tables*

Table No.	Comments	Page
Tab. (1)	Choice of the transducer	45
Tab. (2)	Demographic data	67
Tab. (3)	hemodynamic measurements	67
Tab. (4)	Perfusion index	69

## *List of Figure*

Figure No.	Comments	Page
Fig.(1)	Diagram of brachial plexus	5
Fig. (2)	brachial plexus	8
Fig. (3)	Supraclavicular brachial plexus by ultra sound	10
Fig. (4)	Supraclavicular brachial plexus by ultra sound	10
Fig. (5)	Rib and pleura by ultrasound	11
Fig. (6)	Phrenic nerve by ultrasound	12
Fig. (7)	Branch of brachial artery by ultrasound	13
Fig. (8)	Needle by ultrasound	17
Fig. (9)	Introduction of needle by ultra sound	18
Fig. (10)	Spread of local anesthesia by ultra sound	19
Fig. (11)	Spread of local anesthesia by ultra sound around brachial plexus	20
Fig. (12)	Spread of local anesthesia by ultra sound around brachial plexus	21
Fig. (13)	Spread of local anesthesia by ultra sound inferior to phrenic nerve	22
Fig. (14)	Supraclavicular brachial plexus block catheter inserted in lateral position	23
Fig. (15)	Structure of Bupivacaine	25
Fig. (16)	Local anesthetic movement and equilibration of local anesthetic forms across the nerve membrane and into the sodium channel. B base; BH <sup>+</sup> , cation.	28
Fig. (17)	Treatment algorithm for local anesthetic systemic toxicity..	36
Fig. (18)	Ultrasound machine.	43



<b>Fig (19)</b>	<b>SonoSite probes; from left to right transvaginal, curved array larger footprint (abdominal/general), linear array (small parts/vascular), curved array small footprint (echocardiography)..</b>	<b>44</b>
<b>Fig (20)</b>	<b>In in-plane technique (left), needle is aligned in the plane of thin ultrasound beam allowing the visualization of the entire shaft and the tip. In out of plane technique (right), the ultrasound beam transects the needle, and the needle tip or the shaft is observed as a bright spot in the image</b>	<b>48</b>
<b>Fig (21)</b>	<b>Out-of-plane needling using "walk-down" technique.</b>	<b>49</b>
<b>Fig (22)</b>	<b>Top: Interscalene brachial plexus in transverse view. Bottom: a nerve in longitudinal plane. Note the honeycomb appearance of nerves represented by arrowheads in both planes</b>	<b>50</b>
<b>Fig (23)</b>	<b>Nerves as seen on Ultrasound scan of interscalene area .N = nerve, hypoechoic structures surrounded by hyperechoic rim, IJV = Internal Jugular vein, CA = Carotid artery, ASM = Anterior scalene muscle, MSM = Middle scalene muscle</b>	<b>50</b>
<b>Fig (24)</b>	<b>Sonographic visualization of the cannula. The linear probe produces an image of rectangular cross-section depending on the dimensions of the probe, owing to the frequency-dependent penetration depth (the higher the ultrasound frequency, the smaller the penetration depth). The cannula can be adducted to any point of this cross-section and is identified as a hypoechoic structure with a dorsal acoustic shadow</b>	<b>53</b>

<b>Fig (25)</b>	<b>flow chart of the study</b>	<b>66</b>
<b>Fig (26)</b>	<b>Mean arterial pressure. Data are presented as means, error bars are standard deviations. MAP: Mean arterial pressure. T1: baseline reading, T2: 10 minutes, T3: 20 minutes, T4: 30 minutes.</b>	<b>68</b>
<b>Fig (27)</b>	<b>Heart rate. Data are presented as means, error bars are standard deviations. T1: baseline reading, T2: 10 minutes, T3: 20 minutes, T4: 30 minutes.</b>	<b>68</b>
<b>Fig (28)</b>	<b>Perfusion index. Data are presented as means, error bars are standard deviations. T1: baseline reading, T2: 10 minutes, T3: 20 minutes, T4: 30 minutes. *denotes statistical significance compared to unblocked upper limb. †denotes statistical significance compared to baseline reading</b>	<b>69</b>



## **INTRODUCTION**

The perfusion index is defined as the ratio between the range of absorption of a suitably long light wave (infrared, red) by pulsatile blood flow (arterial) versus non-pulsatile blood flow (venous, capillary, tissue, arterial non-pulsating) and is expressed as a numerical VALUE. PI display ranges from .02% (very weak pulse strength) to 20% (very strong pulse strength).(1).

The perfusion index is an indirect, noninvasive, and continuous measure of peripheral perfusion that provides Useful information to the practicing physician in several clinical settings. Pulse oximetry provides a relatively simple Means to continuously monitor PI in conjunction with other critical parameters, i.e., oxygen saturation and pulse Rate. Furthermore, the PI provides a means of determining an appropriate monitoring site for pulse oximetry. (2)

The Masimo SET infrared signal is influenced primarily by the amount of blood at the monitoring Site, not by the level of oxygenation in the blood. The ratio of AC (pulsatile) to DC (non-pulsatile) components of the IR (infrared) signal correspond to the pulsatile and the non-pulsatile amounts of blood. The relationship of the pulsatile to the non-pulsatile amounts of blood at any particular site corresponds to PI at that site. (3)

Supraclavicular block provides excellent anesthesia for upper limb surgery (4, 5). And is performed at the distal trunk/proximal division level, where the brachial plexus is most compact. This may explain its historical reputation for providing fast onset and complete, reliable anesthesia for the upper limb, and the nickname 'spinal of the arm. (6)



Moreover, ultrasound guidance in supraclavicular block has been introduced and gaining popularity (7). Ultrasound-guided supraclavicular block has many advantages including the higher success rate, faster onset time, and fewer complications (8).

A real milestone in regional anesthesia was the introduction of ultrasound imaging. This auxiliary method enables bedside imaging and evaluation of nerves, adjacent structures (vessels, pleura), needle location and above all spread of anesthetics. The method is particularly useful in patients in whom classical methods may be ineffective (obesity — lack of anatomical landmarks, anatomical variability, difficulties in nerve stimulation, e.g. neuropathies (9).

Peripheral nerve block is a common technique of regional anesthesia the traditional method to evaluate adequacy of the block for surgery is based on loss of sensory response to stimuli, which requires patient cooperation (10). Several methods have been described for objective assessment of the nerve block. Among them is the quantitative evaluation of the block of autonomic innervation to the arm. After successful nerve peripheral nerve blockade local vasodilation. Increase local blood flow and increase skin temperature occur as a result of blockade sympathetic nervous fibers. (11-13)

How soon after administration of the block changes in PI predicted block effectiveness has not been establish and the aim of the study to investigates whether PI is a reliable and objective to detect that is can be used as diagnostic tool for efficiency of supra clavicular block in patients undergoing upper limb orthopedic surgery by Masimo SET pulse oximetry.



## **AIM OF WORK**

1. The aim of this study was to detect that perfusion index by Masimo SET pulse oximetry. Can be used as diagnostic tool for efficiency of supra clavicular block in patients undergoing upper limb surgery.
2. To evaluate range of value of perfusion index where supraclavicular block was efficient.



## **SONOANATOMY**

Peripheral nerve blocks have certain advantages over general anesthesia such as associated analgesia, minimal side effects and a more rapid recovery.(14-16) the supraclavicular brachial plexus block provides reliable anesthesia of the entire upper limb with excellent conditions for tourniquet application. Kulenkampf in 1911 described a technique based on an injection made at the supraclavicular part of the brachial plexus associated with a short onset of action (17).

Despite a few modifications, the supraclavicular approach remained risk prone owing to its association with a high incidence of pneumothorax.<sup>(18)</sup> After Grange et al performed first Doppler guided block in 1978, the evolution of real time ultrasound guided blocks (with or without nerve stimulation) resulted in ease of performance, increased safety profile, and a better quality block.(19-20)

Ultrasound has played a significant role in re-establishing the supraclavicular brachial plexus block in perioperative care. However, a thorough understanding of the anatomy, sonoanatomy, sonotechniques including scanning and needling is essential to ensure a safe and high quality block.(21)

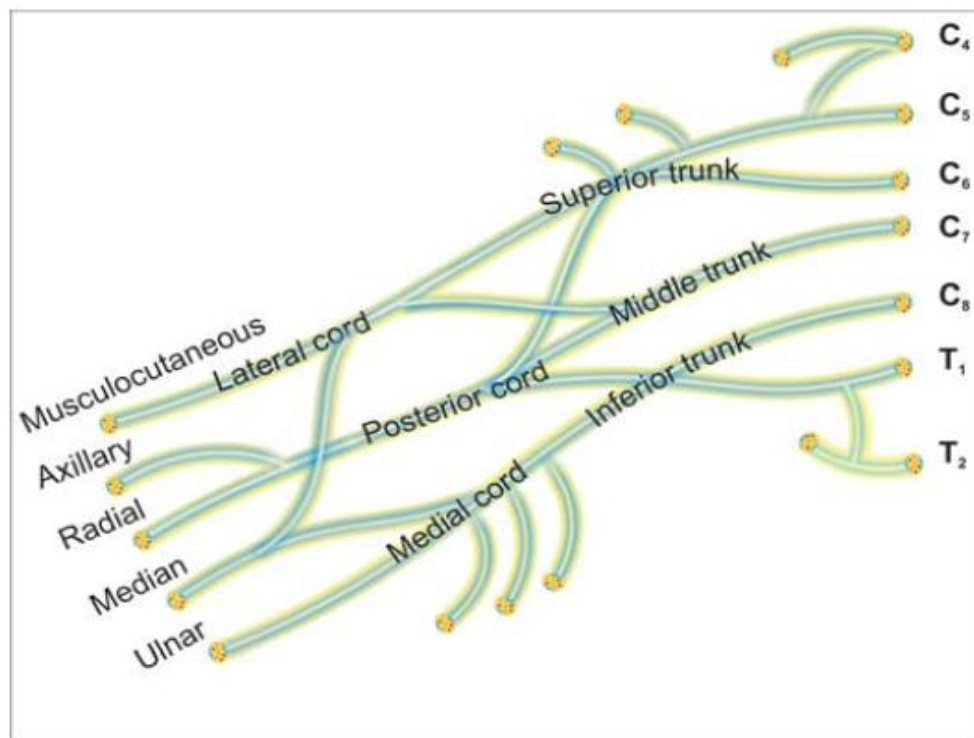
### **Anatomy**

The anterior rami of the cervical and first thoracic spinal nerves (C5-8 and T1) form the brachial plexus. The brachial plexus originates in the neck as 'roots' and terminates in the axilla as 'cords', giving off various branches along its course. The roots of the brachial plexus emerge



between the scalenus anterior and scalenus medius muscles to form trunks which cross the floor of posterior triangle.

Each trunk divides into anterior and posterior divisions and rearranges to form the cords at the outer border of the first rib to continue down into the axilla. Thus the roots of the brachial plexus are situated between the scalene muscles, divisions behind the clavicle and cords in the axilla. The roots and trunks along with their branches form the infraclavicular portion of the brachial plexus (Fig. 1).



**Fig. 1:** Schematic diagram of brachial plexus

The scalenus anterior muscle originates from the tubercles on the C3-6 cervical vertebrae and descends forwards and laterally to be inserted onto the scalene tubercle and adjacent part of the first rib. The phrenic nerve (C3-5) courses on the scalenus anterior within the prevertebral fascia, leaving its medial border near its lower edge and runs between the subclavian artery and vein to enter thorax.