Evaluation of Ultrasound Guided Thoracic Paravertebral Block in Perioperative Pain Management in Patients Undergoing Modified Radical Mastectomy

Thesis

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List of Abbreviations

The following table describes the significance of various abbreviations and acronyms used throughout the thesis. The page on which each one is defined or first used is also given.

Abbreviation	**Meaning**
5-HT3	5-Hydroxytryptamine3
AAA	abdominal aortic aneurysm
AAG	albumins and alpha-1-acid glycoprotein
ADH	anti-diuretic hormone
AMI	acute myocardial infarction
A-mode MPA	amplitude modulation 2-amino-3-hydroxy-5-methyl-4-isoxazole-propionic acid
ARAS	ascending reticular activating system
ASA ASRA	American Society of Anesthesiologists American Society of Regional Anesthesia and Pain
ATP	adenosine triphosphate
BMI	body mass index
B-mode	brightness modulation
CGRP	calcitonin gene-related peptide
CNS	central nervous system
COX-2	cyclooxygenase-2
CPR	cardiopulmonary resuscitation
CPVB	Continuous Paravertebral Block
CTL	costo transverse ligament
CVS	cardiovascular System
DBP	diastolic blood pressure
DVT	deep venous thrombosis

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Abbreviation	**Meaning**
EAAs	excitatory amino acids
ECG	Electrocardiogram
EEG	Electroencephalogram
EICM	external intercostal muscle
GA	general anesthesia
GABA	gamma-aminobutyric acid
HR	heart rate
HT	high-threshold
IASP	International Association for the Study of Pain
IICM	internal intercostal membrane
INR	international normalized ratio
IV	intravenous
LA	local anesthetic
LR	low-threshold
MHz	Megahertz
MRM	multiple reaction monitoring
NGF	Nerve Growth Factor
NIBP	non-invasive blood pressure
NMDA	N-methyl-D-aspartate
NRM	nucleus raphe magnus
NS	nociceptive specific
NSAID	nonsteroidal anti-inflammatory drugs
PACU	post anesthesia care unit
PAG	periaqueductal gray
PCA	patient-controlled analgesia
PCEA	patient-controlled epidural analgesia
PCINA	patient-controlled intranasal analgesia
PCRA	patient-controlled regional anesthesia

Abbreviation	Meaning
PCSA	patient controlled sublingual analgesia
PCTA	patient controlled transdermal analgesia
PEG-2	prostaglandin E2
PIM	posterior intercostal membrane
Pka	Protein kinase.
Pl	Pleura
PONV	Postoperative nausea and vomiting.
PVB	Paravertebral block
PVS	paravertebral space
RA	regional anesthesia
SBP	systolic blood pressure
SNS	sympathetic nervous system
sP	substance P
SP	spinous process
TENS	transcutaneous electrical nerve stimulation
TM-mode	time motion modulation
TPs	Transverse processes
TPVB	Thoracic Paravertebral Block
TPVS	thoracic paravertebral space
US	Ultra-Sound
VAS	Visual analogue score
VATS	video assisted thoracic surgery
VIP	vasoactive intestinal polypeptide
VMM	ventromedian medulla
WDR	wide dynamic range

Introduction

Paravertebral blocks (PVBs) were first performed in 1905 and became a popular technique for the provision of analgesia in the early part of the twentieth century. However, their use declined over the years until a publication by Eason and Wyatt in 1979 began a renaissance **(Eason and Wyatt, 1979)**.

Paravertebral block is now an established regional anesthetic technique creates unilateral somatic and sympathetic nerve block as a result of local anesthetic solution injection close to the spinal nerves along the paravertebralis columna. Paravertebral block may be used in 4 regions: Cervical (C1-C7), Thoracic (T1-T10), thoraco-lumbar (T11-L2), Lumbar or psoas compartment (L2- L5) **(Serbulent et al., 2012).**

The thoracic paravertebral space begins at T1and extends caudally to terminate at T12. Although PVBs can be performed in the cervical and lumbar regions, there is no direct communication between adjacent levels in these areas so most PVBs are therefore performed at the thoracic level **(Tighe et al., 2010).**

Paravertebral block is associated with 0.5%-2% risk of pneumothorax, in addition to the risk of dural puncture with some of the older medially directed landmark approaches. The growth of ultrasound technology increase the ability to visualize the nerve roots, pleura and spread of local anesthetic in the paravertebral space lead to increased interest in performing thoracic paravertebral blocks **(Fleischmann, 2012).**

PVB can provide control of acute and chronic pain (e.g. rib fracture, cancer pain), PVB can also be used as a regional anesthetic technique either alone or combined with general anesthesia for unilateral or bilateral thoraco abdominal surgeries (e.g. Breast surgery with and without axillary dissection , Inguinal and umbilical hernia repair, thoracotomy, major abdominal cases such as partial hepatectomy, nephrectomy, and colectomy as it provides dense block for both somatic and sympathetic nerves) **(Pusche et al., 1999).**

Breast surgery is considered painful and aggressive maneuvers and carry the risk of developing chronic pain if the pain wasn't well controlled in the acute stage associated with the risk of developing phantom breast pain and intercostobrachial neuralgia. So PVBs is one of the indications of Paravertebral block. Breast cancer accounts for 29% of Egypt national cancer institute cases; it is one of the most common causes of cancer death in females. In USA, around 180000 women are diagnosed with breast cancer per year **(Omar et al., 2003)**.

Modified radical mastectomy is one of the most common surgical procedures for treatment of breast cancer during which surgeons remove the breast with the accessible axillary lymph nodes, due to this dissection patients usually suffer from sever post-operative pain, nausea and vomiting, painful restrictive shoulder movement, increase the need for analgesia intra and post-operative, so the use of regional anesthesia (e.g. TPVB) may help in decreasing the need for narcotic analgesia given parentally and provide better pain control and early hospital discharge **(Chassin, 1994).**

Aim of work

The aim of this study is to evaluate the efficacy of US guided paravertebral block compared to systemic opioid, Identify the effect of US-guided paravertebral block on analgesic requirement needed to control post-operative pain and shortening length of hospital stay and to assess surgeon and patient satisfaction.

Literature Review

Chapter l Basic Science

Anatomy

Anatomical Background of the female breast

The female breast lies on the anterior chest wall and extends from the second intercostal space superiorly to the inframammary fold at the sixth or seventh intercostal space inferiorly. On its transverse axis, the breast spans laterally from the midaxillary line to the lateral border of the sternum (Hunt, et al., 2010***)***.

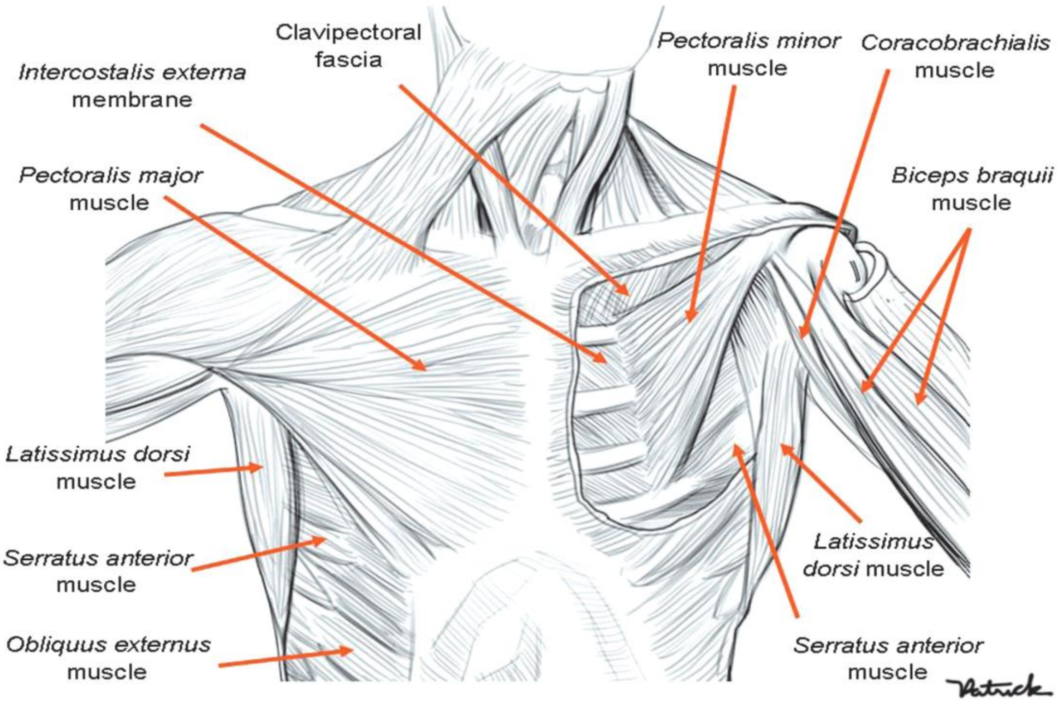

Figure 1: Muscles of the trunk. On the right side of the figure, the pectoralis major muscle has been extracted in order to view the pectoralis minor muscle (anterior view of the trunk) (MACÉA, J. R. & FREGNANI, J. H. T. G., 2006)

Approximately two-thirds of the deep surface of the breast overly the pectoralis major muscle fascia, with the lower lateral thirds covering the serratus anterior muscle and also the upper portion of the external oblique and rectus abdominis muscles. The axillary tail of Spence extends laterally toward the axilla (Hunt, et al., 2010; Sokol ER, et al., 2012).

Nerve Supply of the breast

The sensitivity of the breast is delivered by means of medial, lateral and superior mammary branches of nerves. The lateral branches correspond to the communicating branch and the anterior division of the lateral cutaneous branches of the intercostal nerves of the second to sixth spaces. The medial branches correspond to the anterior cutaneous branch of the intercostal nerves of the same nerves. However, there is only one exception that is the lateral cutaneous branch of the second intercostal nerve, which called the intercostobrachial nerve, which runs to the medial aspect of the arm through the base of the axilla which considered in a great risk during axillary dissection. The superior branches pass to the most cranial region of the breasts and correspond to the supraclaviculares mediales, intermedii and laterals nerves (branches of the plexus cervicalis). The mammary papilla is plentifully supplied by free and branched nerve ends (Pandya S, & Moore RG, 2011; Romrell, L. J. & Bland, K. I., 1998***)***.

Intercostobrachial nerve originated from the lateral branch of the second intercostal nerve, but in very few cases it originated from third intercostal nerve or both second and third intercostal nerves or from the upper three intercostal nerves (Zhu J.J, et al., 2014)**.**

All single trunks of Intercostobrachial that originated from the second intercostal nerve extend to the second intercostal muscles from the posteromedial side of the inferior margin of the pectoralis minor muscle. It almost vertically passed the long thoracic nerve, lateral thoracic artery, and the front of thoraco-dorsal nerve and vessel, and it approximately paralleled with the axillary vein, crossed the axillary loose connective tissue, passed through the front of latissimus dorsi, and was distributed in the skin at its adnexa of the inferior margin so it has a complex course anatomy. Intercostobrachial was found to be mainly distributed in the skin at the posteromedial side of the arm and bottom of the axillary and lateral thoracic walls ***(Zhu J.J, et al., 2014).***

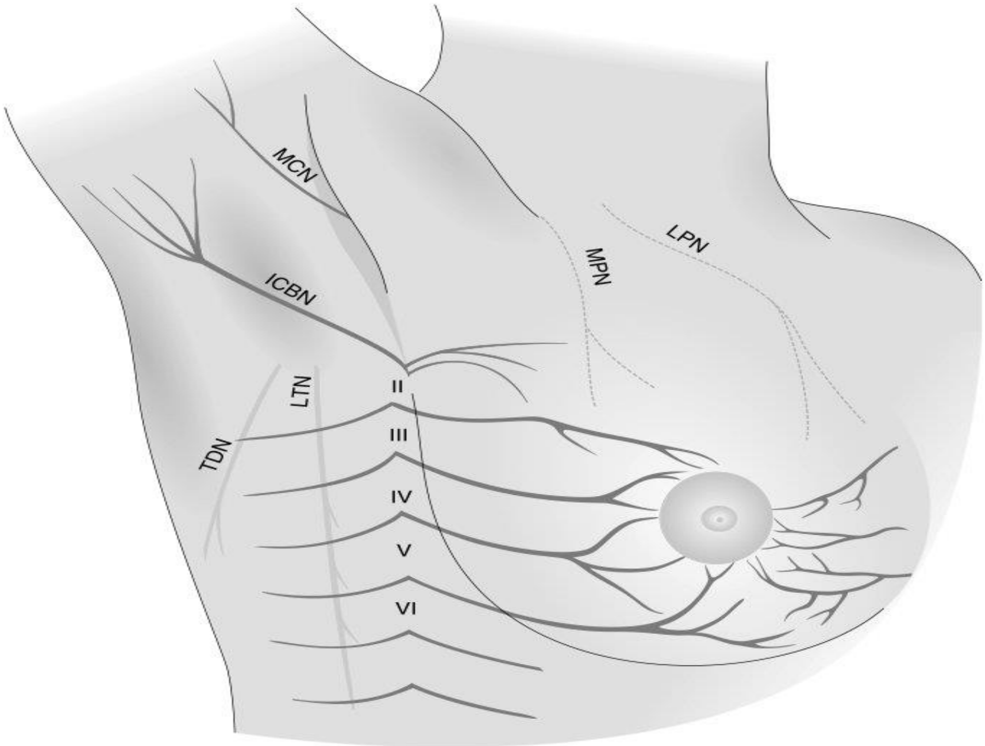

Figure 2: Innervation of the breast and location of nerves at risk during breast cancer surgery. ICBN indicates intercostobrachial nerve (sensory only); II-VI, intercostal nerves 2 to 6, lateral cutaneous branches (sensory only); LPN, lateral pectoral nerve (mixed sensory and motor); LTN, long thoracic nerve (motor only); MCN, medial cutaneous nerve of the arm (sensory only); MPN, medial pectoral nerve (mixed sensory and motor); TDN, thoracodorsal nerve (motor only). (Nelun Wijayasinghe, et al., 2014).

Anatomy of thoracic paravertebral space

The thoracic paravertebral space (TPVS) is wedged in shape with the apex lying laterally and the base medially

Relationships (Dodd et al., 2011 ; Luyet et al.,2009) **:**

Anterolaterally (from posterior to anterior) lie the parietal pleura, the pleural space, visceral pleura and lung parenchyma.

Medially lies the posterolateral portion of the vertebral body, the vertebral disc and the vertebral foreman with its corresponding spinal nerve. Where the space communicates with the epidural space via the intervertebral foramen and, lateral to the tips of the transverse processes, is continuous with the intercostal space. It has been shown that each space communicates inferiorly and superiorly across the head and neck of the ribs.

Laterally the space is bound by the posterior intercostal membrane and the intercostal space.

Posteriorly the TPVS is limited by the superior costotransverse ligament.

Communications:

The TPVS is continuous from T1 to T12. For descriptive purposes the space is split into dermatomes and each segment of the PVS is said to be limited superiorly and inferiorly by the heads of the corresponding ribs. The cervical and thoracic PVS are directly continuous with one another. There are conflicting contrast studies in cadavers with regards a communication between the thoracic and lumbar PVS.The TPVS may be divided into anterior and posterior segments by a thin fibroelastic structure which is the endothoracic fascia. This may affect the pattern of spread of local anaesthetic during TPVB. The existence of the endothoracic fascia is debated (Dodd et al., 2011).

Nerves:

The nerve root passes through its respective intervertebral foramen to enter the medial aspect of the TPVS. There is no fascial sheath