
The Use of Ultrasound-Guided Transversus Abdominis Plane (TAP) Block for Inguinal Herniorrhaphy

Thesis

Submitted for partial fulfillment of M.D. degree in Anesthesiology

By

Gamal Eid Mohamed Eid

(M.S.c.)

Cairo University

Supervisors

Prof. Dr. Amany Ezzat Ayad

*Professor of Anesthesiology,
Faculty of Medicine, Cairo University*

Dr. Loran Mounir Soliman

*Section Head; Orthopedic Anesthesia
Cleveland Clinic- Cleveland, Ohio- USA*

Dr. Ahmed Ehsan El-Agaty

*Professor of Anesthesiology,
Faculty of Medicine, Cairo University*

Dr. Hatem Elmoutaz Mahmoud

*Assistant Professor of Anesthesiology,
Faculty of Medicine, Beni Suef University*

Faculty of Medicine

Cairo University

2013



" قالوا سبحانك لا علم لنا إلا ما
علمتنا إنك أنت العليم الحكيم "

صدق الله العظيم
سورة البقرة (الآية 32)

ACKNOWLEDGMENT:

"First, I would like to say "thanks and praise to Allah", for helping me to make this piece of work come into light"

I would like to express my deep gratitude and appreciation to **Prof. Dr. Amany Ezzat Ayad**, Professor of Anesthesiology, Faculty of Medicine, Cairo University for her eminent supervision, valuable instructions and continuous encouragement during all steps of this study. I think that I was lucky enough to work under her supervision.

I would like to thank **Prof. Dr. Ahmed Ehsan El-Agaty**, Professor of Anesthesiology, Faculty of Medicine, Cairo University and **Prof. Dr. Hatem Elmoutaz Mahmoud**, Assistant Professor of Anesthesiology, Faculty of Medicine, Beni Suef University, for their faithful supervision, understanding, help, and encouragement in initiating and completing this work.

I would like to express my deepest appreciation to **Dr. Loran Mounir Soliman**, Section Head; Orthopedic Anesthesia, Cleveland Clinic Foundation, Cleveland, Ohio, USA to get this work completed in the best way possible as well as for his kind assistance, great professional help and fruitful guidance throughout the entire stay in the USA. He gave me a wonderful opportunity to improve my clinical and research skills.

Last, but far from least, I must thank my family especially my wife and my mother. This work could not have happened without their extraordinary help, passionate assistance and generosity.

Gamal Eid Mohamed Eid

ABSTRACT:

Pain after inguinal hernia repair is still a challenging task especially in the ambulatory setting. TAP block has been suggested as an adequate analgesic option. In this prospective, randomized, double-blind study, our aim was to compare the analgesic efficacy of the transversus abdominis plane (TAP) block with a placebo block in patients undergoing unilateral inguinal hernia repair.

Methods: Following the institutional review board approval, and informed patient consents, fifty adult (ASA) I–IV patients aged 18–80 were enrolled in this study. Under Ultrasound guidance, 20 ml of ropivacaine 0.5% (Group A) or normal saline (group B) were injected in the TAP block. General anesthesia was used for all patients. Serum IL6 levels were measured intraoperative and postoperative. The verbal analog scale (VAS) was recorded immediately postoperative; 1 hour after; the average VAS during the total PACU time; 24 hours postoperative; one month postoperative. The amount of narcotics used (in mg oral-morphine equivalent) in the PACU and in the first 24 hours postoperative as well as anti-emetic drugs were recorded.

Results: Patients in (group A) had significantly lower pain scores than (group B) at all times except the immediate postoperative VAS scores, which were comparable for the two groups. The amount of narcotics used for group A was also significantly lower in the PACU as well as for the first postoperative 24 hours with P value < 0.05 . The serum rise of IL-6 level was lower in group A than group B (however with no statistical significance)

Conclusion: TAP block provided effective analgesia, reducing total 24-hour postoperative analgesic consumption and opioid requirement in patients undergoing unilateral inguinal hernia repair.

Keywords: inguinal hernia, pain, transversus abdominis plane block.

CONTENTS:

List of Tables	iv
List of figures	vi
List of Abbreviations	viii
Abstract	xi
INTRODUCTION	1
REVIEW OF LITERATURE	
• Anatomy of Anterolateral Abdominal Wall	4
• Pain Physiology	15
• Pain after Inguinal Herniorrhaphy	29
• Basics of Ultrasound Guidance In Regional Anesthesia ...	38
• Transversus Abdominis Plane Block	51
HYPOTHESIS	59
PATIENTS AND METHODS	60
RESULTS	71
DISCUSSION AND CONCLUSION	80
SUMMARY	90
REFERENCES	93
ARABIC SUMMARY	111

List of Tables:

	Page
Table 1: Primary Afferent Nerves.	18
Table 2: Algogenic substances.	21
Table 3: Consequences of Poorly Managed Acute Pain.	23
Table 4: Features of Pain Commonly Addressed During Assessment.	28
Table 5: Incidence of Chronic Pain after Inguinal Herniorrhaphy.	31
Table 6: Characteristics of nociceptive and neuropathic pain after inguinal herniorrhaphy.	32
Table 7: Risk Factors for Chronic Pain after Inguinal Herniorrhaphy.	35
Table 8: Advantages and Disadvantages of Spatial Compound Imaging.	42
Table 9: Ultrasound Anatomy of the Anterolateral Abdominal Wall and Related Structures.	54
Table 10: Advantages and Disadvantages of Transversus Abdominis Plane (TAP) Block Procedure.	56
Table 11: Modified Aldrete scoring system.	69
Table 12: Patient demographic data and surgical time expressed as mean $\pm$ SD or ratio (/).	71
Table 13: ASA status for the patients of the two study groups (n=50).	72
Table 14: Type of hernia repair done for the patients of the two study groups (n=50).	72

Table 15:	PACU time for the patients of the two study groups (n=50).	73
Table 16:	Median and range of VAS for the two groups (n=50).	74
Table 17:	Intraoperative and postoperative narcotics given for the patients of the two study groups (n=50) in oral-morphine equivalent (mg).	75
Table 18:	Number of patients of the two study groups who developed PONV and required antiemetic drugs.	77
Table 19:	IL6 was measured intraoperative and in POD1 for the patients of the two study groups (n=50):	78

List of Figures:

		Page
Figure 1:	Muscles of the Anterior Abdominal Wall.	6
Figure 2:	Rectus abdominis muscle and rectus sheath.	8
Figure 3:	The cutaneous branches of the lower intercostal and lumbar nerves.	11
Figure 4:	Afferent nociceptive pathway.	16
Figure 5:	The four elements of pain processing.	20
Figure 6:	Linear verbal analog score and faces pain assessment tool.	27
Figure 7:	Ultrasound transducers for regional blocks. The photograph includes (left to right) broad linear, small footprint linear, curved, sector, and hockey-stick transducers.	43
Figure 8:	Photomicrographs of needles used for regional block.	46
Figure 9:	Schematic drawing of the short-axis (SAX) and long-axis (LAX) out-of-plane (OOP) imaging (left panels), and SAX and LAX in-plane (IP) imaging (right panels).	47
Figure 10:	Median nerve in the forearm viewed in short axis (A) and long axis (B) demonstrating fascicular or honeycomb echotexture. These views were obtained after injection of local anesthetic around the nerve.	50
Figure 11:	The lumbar ‘triangle of Petit’.	53
Figure 12:	The three layers of muscles forming the anterior abdominal wall, from superficial to deep: external oblique, internal oblique, and transversus abdominus.	54

Figure 13:	Local anesthetics installed in the appropriate TAP between the internal oblique and the transversus abdominus muscles. Notice the initial intramuscular injection within the internal oblique muscle (circle).	55
Figure 14:	GE Venue 40 point of care ultrasound machine (GE healthcare®).	63
Figure 15:	21-gauge (100 mm) SonoPlex® echogenic needle by Pajunk.	63
Figure 16:	Muscular layers forming the abdominal wall; with the transversus abdominis plane between the internal oblique and transversus abdominis muscles.	64
Figure 17:	Needle tip appears in the transversus abdominis plane between the internal oblique and transversus abdominis (In- plane approach of the needle).	65
Figure 18:	Injection of the study solution (local anesthetic or saline) which appears in the transversus abdominis plane between the internal oblique and transversus abdominis.	66
Figure 19:	PACU time for the patients of the two study groups (n=50).	73
Figure 20:	Median VAS for the two groups (n=50).	74
Figure 21:	Intraoperative and postoperative narcotics given for the patients of the two study groups (n=50) in oral-morphine equivalent (mg).	76
Figure 22:	Number of patients of the two study groups who developed PONV and required antiemetic drugs.	77
Figure 23:	IL6 was measured intraoperative and in POD1 for the patients of the two study groups (n=50).	79

List of Abbreviations:

AMPA:	α -amino-3-hydroxy-5-methylisoxazole-4-propionic acid
ARKS	Anesthesia Record Keeping System
ASA	American Society of Anesthesiologists
ASIS:	Anterior Superior Iliac Spine
BIS	Bispectral index
BMI	Body mass index
BP	Blood pressure
bpm	Beat per minute
CPNB:	Continuous peripheral nerve block
CT	Computerized Tomography
DCIA:	Deep circumflex iliac artery
DIEA:	Deep inferior epigastric artery
ELISA	Enzyme-linked immunosorbent assay
Fig.:	Figure
G	Gauge
GABA:	γ -amino butyric acid
GE	General Electric
IHN:	Iliohypogastric nerve
IIN:	Ilioinguinal nerve
IL	Interleukin
INR	International Normalized Ratio
IP:	In-plane
IV	Intravenous
kg/m²	Kilogram per square meter
L:	Lumbar
LAX:	Long-axis
m	Meter

m/sec	Meter per second
MAP	mean arterial pressure
mcg	Microgram
mg	milligram
mg/dl	milligram per deciliter
mg/kg	milligram per kilogram
MHz	Mega Hertz
min	minute
ml	Milliliter
mm	Millimeter
n	Number
NMDA:	N-methyl-D-aspartate
NSAIDs:	Non-steroidal anti-inflammatory drugs
OOP:	Out-of-plane
P value	Probability value
PACU	Post Anesthesia Care Unit
pg/ml	Pico gram per Milliliter
POD 1	Postoperative day one
PONV	Postoperative nausea and vomiting
SAS	Statistical analytical system
SAX:	Short-axis
SD	Standard deviation
T:	Thoracic
TAP:	Transversus Abdominis Plane
TAPP	Transabdominal preperitoneal procedure
TGC:	Time Gain Compensation
VAS:	Verbal analog score
WDR:	Wide dynamic-range

β	Beta
δ	Delta
χ^2	Chi-square

INTRODUCTION

Introduction:

Inguinal hernia repair is one of the most common surgical procedures world-wide ⁽¹⁾. More than one million abdominal wall hernias are repaired in the United States annually. Inguinal hernias represent the vast majority of these. It is estimated that more than 700,000 inguinal hernias are repaired each year in the United States ⁽²⁾. For men, the risk is substantial, with a lifetime incidence of 6% to 27% ^(3,4).

One of the most common long and short term complaints after inguinal hernia repair is pain. This is especially worrisome since many patients presenting for hernia repair have minimal or no pain at baseline from their hernia. The challenge is to adequately quantify an individual's pain and compare it to another's pain. Reports continue to surface that up to 60% of patient experience some degree of pain even 12 months after inguinal hernia repair ⁽⁵⁾.

Chronic pain is a significant long-term complication that can occur after inguinal hernia repair and can compromise the patient's quality of life. Postherniorrhaphy pain can be nociceptive or neuropathic. Nociceptive pain is due mainly to tissue injury, inflammatory reaction or scar tissue. Neuropathic pain is due to nerve injury which may be caused by nerve compression or transection. The nerves most at risk for injury are ilioinguinal, iliohypogastric, and genital branch of genitofemoral nerve ⁽⁶⁾.

Intense postoperative pain increases the likelihood of developing chronic pain after hernia repair ⁽⁵⁾. As a consequence of postherniorrhaphy chronic pain, almost one third of patients have limitations in their daily leisure activities. Moreover, treatment of this complication is difficult and controversial, ranging from conservative measures (local injections) to operative exploration and neurolysis ⁽⁷⁾. Neurectomy for chronic pain after inguinal hernia repair is a final option for patients who fail to improve with injections and conservative management ⁽⁵⁾.

Although opioid analgesics are highly effective in decreasing pain in the early postoperative period, their use may be associated with unwanted side effects (e.g., itching, nausea and vomiting). Local Anesthetics are popular adjuvants during outpatient procedures because they can provide perioperative analgesia without opioid-related side effects ⁽⁸⁾. In a recent systematic review, multimodal postoperative analgesic recommendation consists of a combination of paracetamol, a NSAID and a local anesthetic technique ⁽⁹⁾.

The Transversus Abdominis Plane (TAP) Block is a local anesthetic block used to provide analgesia to the anterior and lateral abdominal wall. Rafi et al (2001) ⁽¹⁰⁾ and McDonnell et al (2004) ⁽¹¹⁾ were the first to describe this novel abdominal field block. They described an anatomical landmark technique and provided evidence of blockade to the mid/lower thoracic and upper lumbar spinal nerves (from T6 to L1) as they travelled in the fascial plane between the transversus abdominis and internal oblique muscles.