A COMPARISON BETWEEN ULTRASOUND GUIDED TAP BLOCK VERSUS SURGICAL TAP BLOCK IN ITS EFFICACY AS ADJUNCT TO POSTOPERATIVE PAIN MANAGEMENT IN LOWER MIDLINE OPEN COLORECTAL SURGERY

LEE WON JEE

DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTERS IN ANAESTHESIOLOGY

FACULTY OF MEDICINE
UNIVERSITY OF MALAYA
KUALA LUMPUR

2017

UNIVERSITY OF MALAYA
ORIGINAL LITERARY WORK DECLARATION

Name of Candidate: Lee Won Jee [redacted]

Matric No:MGE130004

Name of Degree: Masters in Anaesthesiology

Title of Project Paper/Research Report/Dissertation/Thesis ("this Work"):

A comparison between ultrasound guided TAP block versus surgical TAP block in its efficacy as an adjunct in postoperative pain management.

Field of Study: Anaesthesiology

I do solemnly and sincerely declare that:

(1) I am the sole author/writer of this Work;
(2) This Work is original;
(3) Any use of any work in which copyright exists was done by way of fair dealing and for permitted purposes and any excerpt or extract from, or reference to or reproduction of any copyright work has been disclosed expressly and sufficiently and the title of the Work and its authorship have been acknowledged in this Work;
(4) I do not have any actual knowledge nor do I ought reasonably to know that the making of this work constitutes an infringement of any copyright work;
(5) I hereby assign all and every rights in the copyright to this Work to the University of Malaya ("UM"), who henceforth shall be owner of the copyright in this Work and that any reproduction or use in any form or by any means whatsoever is prohibited without the written consent of UM having been first had and obtained;
(6) I am fully aware that if in the course of making this Work I have infringed any copyright whether intentionally or otherwise, I may be subject to legal action or any other action as may be determined by UM.

Candi[redacted] DR. LEE WON JEE
No. Pendaftaran Penuh MPM 49155
Pegawai Perubatan Sarjana
Jabatan Anestesiologi
Pusat Perubatan Universiti Malaya

Date: 31/5/17.

Subscribed and solemnly declared before,

Witness's Signature [redacted]

Date: 31/5/17

Name: [redacted]

Designat[redacted]

CONCLUSION: Ultrasound guided TAP block resulted in statistically significant lesser opioid requirement postoperatively and statistically significant better VAS score on movement for the first 48 hours postoperatively in patients who underwent lower midline incision colorectal surgeries.

ABSTRAK

OBJEKTIF: Kajian ini dijalankan secara prospektif, rawak, 'single blinded' untuk membandingkan keberkesanan dan kesesuaian serta melihat perbezaan diantara komplikasi menjalankan TAP block dengan menggunakan ultrasound atau kaedah surgikal.

REKABENTUK KAJIAN: 'Primary outcome' ialah jumlah ubat morfin yang diperlukan oleh pesakit pada 1,6,24,48 jam selepas pembedahan. 'Secondary outcome' ialah kejadian loya dan muntah, skor tahap kesedaran pada 1,6,24,48,72 jam selepas pembedahan dan juga komplikasi TAP blok.

KAEDAH: 40 pesakit berumur 18 tahun sampai 80 tahun , dengan status fizikal ASA I-III yang dijadualkan untuk pembedahan elektif kolorektal yang memerlukan pemotongan abdomen di bahagian bawah tali pusat, dikenalpasti dan diambil kira dalam kajian, dirawakkan dan dibahagikan kepada 2 kumpulan : TAP blok ultrasound dan TAP blok kaedah surgikal. TAP blok diberikan sebelum jahitan otot rektus dalam kumpulan TAP blok kaedah surgikal, manakala TAP blok diberikan selepas jahitan kulit dalam kumpulan TAP blok ultrasound.

KEPUTUSAN: Pesakit dalam kumpulan TAP blok ultrasound memerlukan jumlah morfin yang lebih rendah secara signifikan dari segi statistic dalam 48 jam selepas pembedahan (median 20[18,26]mg vs median 45[40,70]mg $p<0.0001$). Skor VAS ketika rehat pada jam pertama dan keenam selepas pembedahan untuk pesakit TAP blok ultrasound lebih rendah dengan signifikannya dari segi statistik ($p<0.0001$)

Skor VAS ketika bergerak untuk kumpulan TAP blok ultrasound adalah lebih rendah dengan signifikannya dari segi statistik sampai 72 jam selepas pembedahan ($p<0.005$). Tiada laporan komplikasi atau perkara yang tidak diingini berlaku yang berkaitan dengan pemberian TAP blok dan penggunaan ubat opiod dalam dua kumpulan ini. Lagipun, didapati bahawa tiada perbezaan yang signifikan antara kedua dua kumpulan dari segi kejadian loya dan muntah.

KONKLUSI: Penggunaan TAP blok ultrasound mengurangkan keperluan ubat morfin selepas pembedahan dengan signifikannya dari segi statistik dan juga memberi skor VAS semasa pergerakan yang lebih bagus dalam 48 jam pertama selepas pembedahan di kalangan pesakit yang telah melalui pembedahan kolorektal yang melibatkan pemotongan abdomen bawah tali pusat.

ACKNOWLEDGEMENTS/DEDICATIONS

I would like to thank Prof Lucy Chan, Prof Shahnaz and Dr Fadhil for their guidance. I would also like to thank all the APS nurses and ward staff nurses who helped with data collection and monitoring of patients postoperatively. Also, not forgetting the statisticians in RMC (Research management centre) who helped me with the statistical analysis.

TABLE OF CONTENT

LIST OF TABLES

LIST OF ABBREVIATIONS/SYMBOLS

TAP	: transversus abdominis plane
USGTAP	: ultrasound guided transversus abdominis plane
STAP	: surgical transversus abdominis plane
PCAM	: patient controlled analgesia for morphine
IV	: intravenous
PACU	: post anaesthetic care unit
VAS	: visual analogue scale
RCT	: Randomized control trial
UMMC	: University Malaya Medical Centre
ERAS	: Enhanced recovery after surgery
RCT	: Randomized controlled trial

CHAPTER 1: INTRODUCTION

Colorectal operations are among the most frequently performed major abdominal surgical procedures. Postoperative pain requiring bed rest, and persistent gastrointestinal dysfunction, are key factors keeping patients in the hospital. Opioids remain the mainstay of postoperative pain relief but can result in significant adverse effects including sedation, nausea, vomiting, urinary retention, respiratory depression, delayed recovery of colonic mobility, and prolonged postoperative ileus. Although epidural analgesia, traditionally had a key role in postoperative pain management after colorectal surgery, the technique is labour intensive and has the risk of serious neuraxial morbidity albeit rare.

Rafi et al.(2001) first demonstrated a modified technique of abdominal field block known as the transversus abdominis plane (TAP) block. In this technique, the local anaesthetic, injected in the neurovascular plane between the transversus abdominis muscle and internal oblique muscle of the anterior abdominal wall via the lumbar triangle of Petit, blocks the lower intercostal T7-T11, iliohypogastric, and ilioinguinal nerves. Over the years administration of TAP block has evolved to ultrasound guided.

Various studies have shown that TAP block whether via landmark technique or USG provides effective analgesia and reduces postoperative morphine consumption after retropubic prostatectomy, colorectal surgery, caesarean delivery, abdominal hysterectomy, laparoscopic appendicectomy and incisional hernia repair.

However, in some reports the safety of TAP blocks has been raised. There have also been reports of liver injury caused by needle damage. Theoretical concerns have also been discussed regarding the risk of femoral nerve palsy. Landmark techniques and USG placement of TAP blocks may also be more difficult in obese patients.

Recently, surgically administered TAP blocks have been described, allowing a more accurate placement. This involves the operating surgeon identifying the anatomical layers under direct vision when closing the abdomen and placing the local anaesthetic accordingly. This has the advantage of avoiding inadvertent injection into the incorrect layer or damaging deeper structures. The importance of this study is to evaluate the efficacy of both USG TAP and surgically administered TAP block as an adjunct of postoperative analgesia in patients undergoing colorectal resection.

CHAPTER 2: LITERATURE REVIEW

Transversus abdominis plane (TAP) block was first described by Kuppuvelumani et al in 1993(Kuppuvelumani, Jaradi, & Delilkan, 1993) and was formally documented by Rafi in 2001(Rafi, 2001).

There are 11 published meta- analyses around the effects of TAP block. The most recent was published in September 2015 and the first was a Cochrane review by Charlton et al(Charlton, Cyna, Middleton, & Griffiths, 2010) published in 2010. They assess the effects of TAP block, most provided by ultrasound guided technique and to the lesser extend, the landmark technique. There were no meta analyses published on the effects of surgically administered TAP block. However there were 2 small randomised controlled trial which were conducted to study the efficacy surgically administered TAP block as an adjunct to postoperative analgesia(Owen, Harrod, Ford, Luckas, & Gudimetla, 2011; Urfalıoğlu et al., 2016

)The most recent meta-analysis was published in the September 2015 issue of Anaesthesia and Analgesia (Baeriswyl, Kirkham, Kern, & Albrecht, 2015). It included 31 controlled trials and 611 adult patients in all. Its primary focus was on the opioid-sparing effects, and the cumulative morphine consumption at 6 hours postoperatively, and its secondary objectives were 24-hour morphine consumption, pain ratings, and postoperative nausea and vomiting. It showed that the ultrasound-guided TAP block was associated with a reduced intravenous morphine consumption at 6 hours postoperatively by a mean difference of -6mg, independent of the type of surgical anaesthesia (general anaesthesia, spinal anaesthesia with or without intrathecal long-acting opioid). The beneficial effect

of cumulative morphine consumption was also seen at 24 hours (mean difference -11mg). Pain ratings were reduced at 6 hours postoperatively but no effect was seen in the incidence of postoperative nausea and/or pruritus, either at rest or during movement. The authors concluded, "Ultrasound-guided TAP block provides marginal postoperative analgesic efficacy after abdominal laparotomy or laparoscopy and caesarean delivery. However, it does not provide additional analgesic effect in patients who also received spinal anaesthesia containing a long-acting opioid." Thus the result of this most recent review is in line with the ones previously published(Baeriswyl et al., 2015).

Open or surgically placed TAP blocks have been described as adjuncts in plastic, gynaecological and also colorectal surgery through a midline incision. Owen et al.described a technique of performing an open surgical TAP block in women undergoing caesarean section under spinal anaesthesia. They found a significantly lower morphine requirement in those with a surgically placed TAP compared with no TAP block(Owen et al., 2011).

.

Bharti et al. performed a small randomised controlled trial by injecting either 40mls of 0.25% levobupivacaine or saline from inside the abdominal wall into the TAP plane for colorectal resections. No local infiltration on subcutaneous were given in the saline group. A 65% decrease in 24 hour total morphine consumption was observed in the TAP group compared with the control group. The cumulative morphine requirement was also significantly lower in the TAP group at all time points. Although the time to first request for morphine was comparable, the subsequent doses of morphine were required at significantly longer time intervals in the TAP group than in the control group. TAP group

patients had significantly lower pain scores at rest and on coughing as compared with the control group(Bharti, Kumar, Bala, & Gupta, 2011).

In a study by Brady et al, it was found that surgical TAP block significantly reduces the postoperative opiod requirements in the first 24 hours following an open right hemicolectomy. The morphine requirement in the TAP group was half of that in the control group during the second 24 hours. In addition, lower levels of excessive sedation were found in the second 24 hours in those patients who had received a surgically placed TAP block(Brady, Ventham, Roberts, Graham, & Daniel, 2012).

Even though ultrasound guided TAP block is relatively safe, some reports on its safety has been raised. There were 2 isolated incidents reported. In 2008, Farooq et al reported a case study where the patient sustained blunt liver trauma post ultrasound guided TAP block(Farooq & Carey, 2008). In 2006, a case study was reported where a 6 years old patient developed bowel hematoma post ilioinguinal and iliohypogastric block(Frigon, Mai, Valois-Gomez, & Desparmet, 2006). Surgical TAP block certainly allows more accurately placement of the needle and the TAP block. This involves the operating surgeon identifying the anatomical layers under direct vision when closing the abdomen and injecting the local anaesthetic agent(Owen et al., 2011).

In conclusion, TAP block is relatively safe and interesting block that can be provided by ultrasound guided technique or intraoperatively by the surgeon, providing postoperative analgesia, and a reduced need for morphine analgesia during the first 24 to 48 hours following abdominal procedures. There is however, a need for further studies to compare the efficacy of TAP block under ultrasound guidance and TAP block administered surgically as adjuncts in postoperative analgesia.

CHAPTER 3: METHODOLOGY

This randomised controlled study (RCT) was carried out over a period of 10 months from June 2016 to April 2017 in Anaesthesia department of UMMC. Sample size was based on previous RCT done by Sivarapu 2013 on gynaecology patients which calculated sample size (n) was 18 per group based on sample size calculator with a confidence interval of 95% with statistical power 0.8. Thus, anticipating a 10% drop out rate, 20 patients were recruited into each group. After due approval from ethical review board and written consent, 40 patients with ASA (American Society of Anaesthesiologist) physical status of I - III, 18 to 80 years of age planned for lower midline laparotomy for open colorectal surgery with incision length limited to 15 cm will be included in the study. Exclusion criteria were patient refusal, patients with coagulopathies, renal insufficiency, congestive heart failure, contraindications to local anaesthetic agents, chronic opioid dependence, drug addictions, BMI>40kg/m2, obstructive sleep apnoea, contraindication to opioids use and inability to use patient controlled analgesia (morphine).

During the preoperative visit, written informed consent was obtained followed by instruction on how to utilize the intravenous (IV) patient- controlled analgesia(PCAM) and explanation regarding the pain rating score (VAS) with scores of 0 to 10, whereby a score of 0 indicated no pain and 10 was the worst experienced pain. PCA was used to quantify postoperative morphine requirement. All patients were randomized into 2 groups, by means of computer-generated randomization table.

Group I received ultrasound guided TAP block and Group II received TAP block administered by surgeon, 20 patients in each group. For the purpose of study and to

control confounding factors, all patients underwent general anaesthesia, 1mcg/kg of fentanyl and propofol 2-2.5mg/kg intravenously and maintained with inhalational agent (Sevoflurane) in 50% oxygen with air. Airway was maintained with endotracheal tube and mechanical ventilation was continued on continuous mandatory ventilation (CMV) mode. Morphine 0.1mg/kg was given before incision. All patients received TAP block from standardised personnels (both anaesthetist and surgeons).

Group I patients received ultrasound guided TAP block at end of operation after skin closure with levobupivacaine 2mg/kg diluted to 40mls with saline 0.9%. 20 mls of local anaesthetic agent was injected via TAP block at each side of abdominal wall. TAP block was done under aseptic technique with ultrasound guidance using linear probe (7-12MHz) orientated transversely to the anterolateral abdominal wall where the three muscle layers is most distinct. Probe was then moved posterolaterally towards midaxillary line just superior to iliac crest (triangle of Petit) after recognising the plane between internal oblique and transversus abdominis muscle. The Echoplex Vygon 21g 150mm needle was used as the block needle, introducing anteriorly via in-plane approach, advancing posteriorly under ultrasound visualisation. Drug is then injected visualising hypoechoic deposition of injectate with hydro dissection of transversus abdominis plane confirms drug placement.

Group II also received TAP block with levobupivacaine 2mg/kg diluted to 40 mls with saline 0.9%. 20 mls of local anaesthetic agent was administered by surgeon in direct view of abdominal muscles right before closure of rectus at both side. Both groups were provided with patient controlled analgesia with morphine.

In the recovery bay, at 1 hour post operation, patients were assessed for unilateral/failed block by testing of cold sensation with ice. Any patients with unilateral/failed block was excluded from the study. Rescue analgesia of 0.5mcg/kg fentanyl was given as rescue analgesia when pain score was more than 4.

As the primary outcome parameter, we evaluated the total opioid consumption at 1,6, 24, 48 hours postoperatively . Oral analgesia was commenced at 48hours post operation. Secondary endpoints includes pain ratings(VAS), incidence of postoperative nausea and vomiting, sedation score at 1, 6, 24, 28, 72 hours postoperatively, length of stay in recovery bay, time needed to perform TAP block, incidence of unilateral TAP block or failed block, incidence of adverse complications: wound breakdown, infection, hematoma at injection site, local anaesthetic agent toxicity.

The data was analysed using the SPSS (Statistical Package for The Social Sciences) Version 22.0 software. Chi-square test or Fisher's test was used for categorical variables in the demographic data and VAS scores. Independent t-test was used to determine any significant differences for continuous variables such as age, weight, height, BMI, duration of post anaesthetic recovery area, performance time and total postoperative morphine usage. A p- value of less than 0.05 was considered statistically significant.

CHAPTER 4: RESULTS

Forty patients were enrolled into this study and randomized into either Group I or Group II. The demographic data, performance block time and duration of stay at the post anaesthetic recovery area are shown in Table 4.1. There were no demonstrable significant difference in the demographic data of both groups. There is however a faster performance time in group II and a longer duration of stay at the recovery area in group II. There were no dropouts from both groups due to failed blocks.

Data on the perioperative opioid requirement is shown in Table 4.2. Patients in Group I required significantly less total morphine usage at 1, 6, 24, and 48 hours postoperatively. PCA morphine usage within the first 24 hours postoperatively in the surgically administered TAP block (Group II) had a median of 34.5mg which was comparable to the results of study done by RR Brady et al. PCA morphine usage within the first 24 hours postoperatively in the ultrasound guided TAP block (Group I) had a median of 13mg which was comparable to the study done by Belavy et al.

Pain scores during different time intervals at rest and at movement is shown in Table 4.3. At rest, statistically significant differences for the pain score occurred at 1 and 6 hours postoperatively, where patients in Group I scored lower on the VAS than patients in Group II. On movement , pain scores were also found statistically significant at all periods till 72 hours postoperatively for Group I.

There were no specific complications related to the block for all patients during the study period. There were only 2 reported incidence of mild PONV, both from group II.

There were no incidence of other adverse effects of opioids such as excessive sedation or respiratory depression.

Table 4.1 Demographic data, performance time, and duration of stay at the post anaesthetic recovery area. Values expressed as mean(standard deviation) or numbers(percentage), where appropriate.

	Group I (n=20)	**Group II (n=20)**	***p* value**
Age yr)	68.5(10.9)	63.3(15.5)	0.220
Weight (kg)	54.6(12.2)	61.4(14.2)	0.114
Height (cm)	158.0(8.19)	160.9(5.7)	0.206
BMI	22.4(4.3)	23.5(4.2)	0.389
Gender: Male Female	55% 45%	55% 45%	0.445
Race : Malay Chinese Indian	25% 65% 10%	40% 45% 15%	0.445
ASA physical status: I II III	20 65 15	35 55 10	0.553
Performance time (min)	5.0(0.5)	1.2(0.2)	0.0001
Recovery time (hr)	1.2(0.24)	1.9(0.17)	0.0001

Table 4.2. Intraoperative and postoperative opioid requirement. Value expressed as median (25th percentile, 75th percentile) as appropriate.

	Group A (n=20)	Group B (n=20)	*p* value
Total morphine requirement(mg) at: 1 hour	1(1,2)	5(4,7)	0.0001
6 hour	5(2.6,6.0)	13(9,15)	0.0001
24 hour	13(12,18)	34.5(32,40)	0.0001
48 hour	20(18,26)	45(40,70)	0.0001

Table 4.3. VAS scores. Values expressed as median(25th percentile, 75th percentile)

	Group A (n=20)	Group B (n=20)	*p* value
VAS score (rest) at: 1 hour	0(0.0.8)	2(1,2)	0.003
6 hour	1(1,2)	3(2,3)	0.011
24 hour	1(0,2.8)	1(1,3)	0.395
48 hour	1(1,1.8)	1(1,2)	0.503
72 hour	1(0,1.8)	1(0,2)	0.742
VAS score (movement) at: 1 hour	2(0.3,3.8)	3(2.3,4.8)	0.003
6 hour	3.5(2.3,4.0)	4(4,5)	0.016
24 hour	3.0(2,4)	4(4,4)	0.022
48 hour	3(3,3)	4(3,4)	0.0001
72 hour	3(2,3)	3(3,4)	0.005

CHAPTER 5: DISCUSSION

The aims of this study were primarily to determine the quality of analgesia (as assessed by 48 hours morphine requirement and VAS scores), to note the incidence of side effects (as assessed by sedation score and PONV) which follow opioid usage and incidence of complications from TAP block administration itself (as assessed by LA toxicity, hematoma, infection, wound breakdown).

In this study it was found that ultrasound guided TAP block(USG) provided better quality analgesia as compared to surgically administered TAP block. Total morphine consumption was found to be statistically significant lower in the USG TAP block group at 1, 6, 24 and 48 hours postoperative period. These findings were in agreement with a randomised controlled trial conducted by RR Brady et al. where they found that in patients who received surgical TAP block and underwent lower midline open right hemicolectomy, total morphine consumption was 42.1mg(Brady et al., 2012), where this is comparable with 34.5mg in patients of this study who received surgical TAP block in the first 24 hours postoperatively. This study also showed that total morphine usage in the first 24 hours postoperatively in the USG TAP block group was 13mg which was comparable to a randomised controlled trial study done by belavy where total morphine consumption was 18mg in the USG TAP block too(Belavy, Cowlishaw, Howes, & Phillips, 2009).

In terms of VAS score, in a study published in the Brazilian journal of anesthesiology on comparison between USGTAP vs STAP block in obese patients following caesarean section(Urfalıoğlu et al., 2016

) there were no statistically significant differences in VAS score in the first 24 hours postoperatively. However, it was not mentioned by the authors whether these scores were taken at rest or at movement. Also, in the study above, 1g of intravenous paracetamol and 50mg of tramadol were given 30 minutes before end of operation which can act as confounding factors and may affect the results of the VAS scores. In our study, it was found that VAS scores were statistically significantly lower at rest at 1 hour and at 6 hours postoperatively for the USG TAP block group. While VAS scores at movement were found to be statistically significantly lower till 72 hours postoperatively for USG TAP block group. There are no studies done till date which compares the quality of post operative analgesia between USG TAP block and surgically administered TAP block in lower midline colorectal surgeries.

There were no complications observed in both USG TAP block and surgically administered TAP block groups. USG for regional anaesthesia has not been conclusively demonstrated to improve safety, however, visceral and vascular injury resulting from TAP blocks might be reduced(Hebbard, Fujiwara, Shibata, & Royse, 2007). One of the major strengths of surgically administered TAP blocks in open surgery is the ability to infiltrate the correct anatomical layer under direct vision, avoiding potential complications of the technical difficulties which may occasionally by encountered regarding probe insertion and distinction of the abdominal muscle layers because of obesity.

Despite the statistically significant lower morphine usage in USG TAP block group, PONV was comparable in both groups. Only 2 incidences of mild PONV were reported in the STAP group. Intravenous metoclopramide, which are prescribed to all patients on PCAM could have had an impact on reducing the occurrence of PONV in this study. There were no incidence of over sedation in both groups.

CHAPTER 6: LIMITATIONS

There were several limitations of this study. First, in the surgical TAP block group, the blocks were given not by one designated surgeon but by 3 different surgeons, where as in the USG TAP block group, the block was given by a designated personnel. This could have produced a different statistical result as all surgeon has different skills.

Second, the procedures done during colorectal surgeries were rather diversified. The procedures included hemicolectomy, reversal of Hartman, ultra low anterior resection and anterior resection. As we all know, TAP block can only block pain from abdominal wall and not visceral pain, hence different procedures may affect pain scores differently. Third the postoperative VAS score at 1 hour which was presented in the results did not reflect the pain experienced by the patients upon arrival to the post anaesthetic recovery area. It would have been better to have recorded the pain upon arrival as it may have produced a different statistical result and also linked with rescue analgesia which was administered at that time.

If this study were to be repeated in the future, it would benefit from monitoring the time till first rescue analgesia and dose given, time till first morphine requirement, having only one designated personnel (anaesthetist and surgeon) to administer TAP block, including only one type of operative procedure in the inclusion criteria, and also to monitor VAS score at immediate postoperative period in PACU.

CHAPTER 7: CONCLUSION

Both USG and surgical TAP block were shown to be safe in this study. No incidence of adverse events/complications such as wound breakdown, infection, hematoma at injection site, and local anaesthetic agent toxicity was reported in both arms. However USG TAP block definitely showed better efficacy in providing postoperative analgesia in patients following lower midline incision colorectal surgeries. Total morphine requirement in this arm was significantly lower till 48 hours post operatively. VAS score at movement in this arm was also significantly lower till 72 hours post operatively. Good postoperative analgesia management is an important key aspect to ERAS and early mobilisation of surgical patients to reduce postoperative morbidity and mortality. Despite that, surgically administered TAP block can still play an important role in providing postoperative analgesia in certain circumstances such as in obese patients, and where there is no availability of ultrasound machine or trained personnel to perform USG TAP block.

CHAPTER 8: REFERENCES

Baeriswyl, M., Kirkham, K. R., Kern, C., & Albrecht, E. (2015). The Analgesic Efficacy of Ultrasound-Guided Transversus Abdominis Plane Block in Adult Patients: A Meta-Analysis. *Anesth Analg, 121*(6), 1640-1654. doi: 10.1213/ANE.0000000000000967

Belavy, D., Cowlishaw, P. J., Howes, M., & Phillips, F. (2009). Ultrasound-guided transversus abdominis plane block for analgesia after Caesarean delivery. *Br J Anaesth, 103*(5), 726-730. doi: 10.1093/bja/aep235

Bharti, N., Kumar, P., Bala, I., & Gupta, V. (2011). The efficacy of a novel approach to transversus abdominis plane block for postoperative analgesia after colorectal surgery. *Anesth Analg, 112*(6), 1504-1508. doi: 10.1213/ANE.0b013e3182159bf8

Brady, R. R., Ventham, N. T., Roberts, D. M., Graham, C., & Daniel, T. (2012). Open transversus abdominis plane block and analgesic requirements in patients following right hemicolectomy. *Ann R Coll Surg Engl, 94*(5), 327-330. doi: 10.1308/003588412X13171221589856

Charlton, S., Cyna, A. M., Middleton, P., & Griffiths, J. D. (2010). Perioperative transversus abdominis plane (TAP) blocks for analgesia after abdominal surgery. *Cochrane Database Syst Rev*(12), CD007705. doi: 10.1002/14651858.CD007705.pub2

Farooq, M., & Carey, M. (2008). A case of liver trauma with a blunt regional anesthesia needle while performing transversus abdominis plane block. *Reg Anesth Pain Med, 33*(3), 274-275. doi: 10.1016/j.rapm.2007.11.009

Frigon, C., Mai, R., Valois-Gomez, T., & Desparmet, J. (2006). Bowel hematoma following an iliohypogastric-ilioinguinal nerve block. *Paediatr Anaesth, 16*(9), 993-996. doi: 10.1111/j.1460-9592.2006.01909.x

Hebbard, P., Fujiwara, Y., Shibata, Y., & Royse, C. (2007). Ultrasound-guided transversus abdominis plane (TAP) block. *Anaesth Intensive Care, 35*(4), 616-617.

Kuppuvelumani, P., Jaradi, H., & Delilkan, A. (1993). Abdominal nerve blockade for postoperative analgesia after caesarean section. *Asia Oceania J Obstet Gynaecol, 19*(2), 165-169.

Owen, D. J., Harrod, I., Ford, J., Luckas, M., & Gudimetla, V. (2011). The surgical transversus abdominis plane block--a novel approach for performing an established technique. *BJOG, 118*(1), 24-27. doi: 10.1111/j.1471-0528.2010.02779.x

Rafi, A. N. (2001). Abdominal field block: a new approach via the lumbar triangle. *Anaesthesia, 56*(10), 1024-1026.

Urfalıoğlu, A., Bakacak, M., Boran, Ö. F., Yazar, F. M., Arslan, M., & Öksüz, H. (2016

). Ultrasound-guided versus surgical transversus abdominis plane block in obese patients following cesarean section: a prospective randomised study. *Brazilian Journal of Anesthesiology (English Edition)*. doi: http://doi.org/10.1016/j.bjane.2016.07.009

APPENDIX A: FLOW CHART OF RCT.