

Effect of Transverse Abdominis Plane Block on Chronic Post-Operative Pain—A Review

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Abstract

Chronic post-operative pain is a recognized adverse consequence of surgery; managing and preventing it are always a better choice. Proper choice of Anesthetic technique, use of combined anesthesia and pre-emptive analgesia may prevent and decrease the incidence of chronic post-operative pain. Transverse abdominis plane block (TAP Block) is a regional anesthesia technique following abdominal surgeries which involve injection of a large amount of local anesthetics in TAP, an anatomical space between the internal oblique and transverse abdominis muscle. The aim of this review is to show the effect and uses of TAP block as a combined anesthesia and multimodal analgesia in preventing chronic post-operative pain.

Keywords

Chronic Post-Operative Pain, Transverse Abdominis Plane Block, Regional Anesthesia, Multimodal Analgesia

1. Introduction

Chronic post-operative pain (CPOP) is the most common type of chronic pain in patients attending pain clinic. A survey done about on 5000 patients found that 34.2% of patients visiting clinic have degenerative diseases and the second largest 22.5% of patients have chronic pain following the surgical procedure [1]. International Association for the study of pain (IASP) defines chronic pain as pain without apparent biological value that has persisted beyond the normal tissue; healing time is usually considered 3 months, however when it comes to CPOP, the working definition as mentioned in **Table 1** written by Marcae and Davies, which is adopted and still frequently used [2]. Pain persists in most of the patients after thoracotomy, amputation, or breast surgery and even for lower abdominal surgeries

Table 1. CPOP definition by Marcae and Davies [2].

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- 1) Pain developing after surgical procedures.
 - 2) Pain of at least two months of duration.
 - 3) Causes such as malignancy or chronic infection should be excluded.
 - 4) Pain continuing from a preexisting pain also must be excluded.
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such as hernia and cesarean section. Surgeries between 2005-2006 done in UK show the highest of 50% - 85% of chronic pain's patients with amputation and 5% - 35% of incidence of chronic pain in hernia [3]. Mild post-operative chronic pain can significantly impact function and quality of life, whereas severe chronic pain is devastating in nature [4].

There are several risk factors which result in Chronic postoperative pain including preoperative, intraoperative and postoperative [1]. In case of abdominal surgeries, pain is due to incision in abdominal or visceral wall. Although the conventional method of anesthesia is effective, the post-operative risk of nausea, vomiting, opioids effects, urinary retention is usually inevitable. Several studies done say transverse abdominis plane block (TAPB) provides a good intraoperative and acute pain relief which also results in decrease in use of opioids resulting less opioids related complications, compared with anesthetic techniques like intravenous and spinal/epidural anesthesia with less complications [5] [6] [7] [8] [9]. However, there has been less research on the relationship between CPOP and TAPB. Therefore, this review intends to establish the relationship between CPOP and TAPB and to show the usages of TAPB as multimodal anesthesia and pre-emptive analgesia.

2. Mechanism of CPOP

The actual mechanism of chronic pain after surgery is still not yet understood very clearly. It may be in part a failure of the nervous system to return to its initial settings before the injury [10]. Even in a single case of surgery different mechanism might be involved [11]. Usually chronic pain has their origins in an episode of acute pain which is particularly true of chronic pain after surgery. Acute pain due to surgical injury or incision initiates series of neurochemical reactions at the site of injury and also initiates a cascade of changes leading to sensitization in CNS. The occurrence of this hyperalgesic state may be advantageous and lead to less using of the injured part gradually allowing healing [10].

Initially it was believed that persistent post-surgical pain primarily is neuropathic in nature, but nowadays it is thought ongoing nociception might as well be playing role in this condition and blocking nociception during any part during the perioperative period may help prevent the occurrence of persistent pain after surgery [12] [13]. There is the neuroplasticity process also known as the physical remodeling of neuronal cytoarchitecture; a complex and in constant change in membrane excitability, reducing inhibitory mechanisms and increasing the excitatory synaptic efficacy. It occurs shortly after persistent acute pain which leads to the transition from acute pain into a state of chronic pain [14] [15]. It is said the

process of neuroplasticity starts with the incision which causes surgical stimulation, which is maintained throughout the postoperative inflammatory process and ends only with the surgical healing [16]. Neuroplasticity are of two types, 1) peripheral, 2) central. Due to the activation on intracellular cascades with lower threshold, the injured tissues or inflammatory mediator cells releases inflammatory mediators which causes peripheral neuroplasticity, responsible for local hyper-excitability of high threshold peripheral nociceptive terminations. There may also be pain perception with a weaker stimulation. Where as in central neuroplasticity there is a synaptic change of spinal cord with the amplification of pain signal [12]. By the stimulation of peripheral nociceptive, intracellular kinases pathway is activated at the spinal cord dorsal horn changing ionic channels flow and the density of receptors and neurotransmitters. Post-synaptic hyper-excitability occurs due to central sensitization (CS) which increases the activity and density of AMPA and NMDA receptors. The increase of glutamatergic synapses in the spinal cord dorsal horn reinforces nociceptive stimulation transmission and recruits non nociceptive stimulation to the pain pathway. Due to activation of Nitric oxide (NO) and Kinase-C protein increase in the excitability of nociceptive neurons occurs [14]. NO induces sensitization of nociceptors. It increases the prostaglandin E2 release inhibiting the action of endogen ant-nociceptive substance on peripheral receptors acting directly on nociceptors. By the activation of NMDA receptor with subsequent production of NO, central sensitization is partially mediated [17]. After the induction of CS, there is an increase in responsiveness of neurons and even those which normally have ineffective synapse for stimulations, inoculate and activate neuronal pain transmission [12].

Whole process of Central Sensitization is considered to be very important factor for the development of persistent pain; hence the pharmacological interventions, good perioperative pain control and surgical techniques can be considered for minimize the central sensitization [18].

3. Regional Anesthesia and Analgesic Consideration Affecting CPOP

Local anaesthetics are used in regional anesthetic technique to block the conduction of impulses along nerves. It may possibly prevent the barrage of nociceptive inputs into the dorsal horn preventing central sensitization by minimizing the transmission of signals to or within the spinal cord. Peripheral nerve blocks and would infiltrations interrupt impulses in peripheral nerves whereas Subarachnoid block and edpiural block techniques act on the nerve roots [1]. A Cochrane review done among 23 RCTs and data pooled from 250 patients in three trials, found that epidural anesthesia for thoracotomy to be beneficial in reducing the risk of chronic pain at 6 months [4]. In case of limb amputation, nerve injury is unavoidable. It is one of the high risk factor associated with CPOP, however, perioperative epidural analgesia reduces the incidence of severe phantom limb pain [19]. Spinal anaesthesia has also been shown to be beneficial relative to general anaesthesia in reducing the risk of chronic pain after caesarean section [20]. The above studies gives some evidence for the benefit of regional anesthetic techniques in some of

the surgeries in reducing the chronic pain after surgery but still yet further studies has to be carried out for different surgical approach.

4. Transverse Abdominis Plane Block

Anatomically, spinal nerves arising from T7 to T11 run along the neurovascular plane lying in the anterior abdominal wall between internal oblique and the transverse abdominis muscle called the Transverse Abdominis Plane (TAP). The L1 (ilioinguinal and iliohypogastric) and T12 (subcostal nerve) also travels through the same plane [21]. Local anesthetics deposited in this area will target the nerves running in TAP, blocking the pain signals below and upper umbilicus [21]. The above nerve segments while travelling the TAP, branches individually and communicate extensively with others. It was noted that nerve segments entered the TAP in an inferolateral distribution from the costal margin such that segments from T6 entered to the linea alba whereas segments from T9 entered near the anterior axillary line (Figure 1). Between the costal margin and the ileum, near the triangle of petit along the anterior axillary line, nerves running in the TAP originate strictly from T9-L1 [22]. Rafi [23] and McDonnell [24] were the first to describe this novel abdominal field block and described an anatomical landmark technique, and provided evidence of blockade to the mid/lower thoracic and upper lumbar spinal nerves as they travelled in the fascial plane between the transversus abdominis and internal oblique muscles. TAP Block under ultrasound guidance has become a regional block technique with wide indications, which can be used for postoperative analgesia in patients with less complications. Three common approaches Subcostal, midaxillary and ilioinguinal-iliohypogastric can be used for the TAPB and each respected approach is contingent on the type of the surgical procedure and location [25]. This method is similar to that of nerve block of groin and abdominal nerve but more extensive. Although more scholars believe that unilateral TAPB can block from T7-L1 of the anterior abdominal wall, muscles and peritoneum, still clinically some individuals seemed to have poor analgesic effect where the block couldn't meet the requirement [26].

5. Clinical Studies on TAP Block and Chronic Post-Operative Pain

Poorly controlled perioperative pain and acute phase pain plays a significant role in the development and severity of chronic post-operative pain [27] [28]. TAP-Block as multimodal analgesia and as a part of combined anesthesia plays a good role in variety of abdominal surgery and improves the postoperative analgesic effects, enhances recovery [29] [30] [31] [32], and also prevents chronic post-operative pain in compared with spinal and general anesthesia [33]. Study characteristics and design are presented in Table 2.

6. Discussion

Chronic post-operative pain following inguinal herniorrhaphy accounts for 12% of the patients, effecting quality of life as well [39]. Topal *et al.* [33] in a retrospective

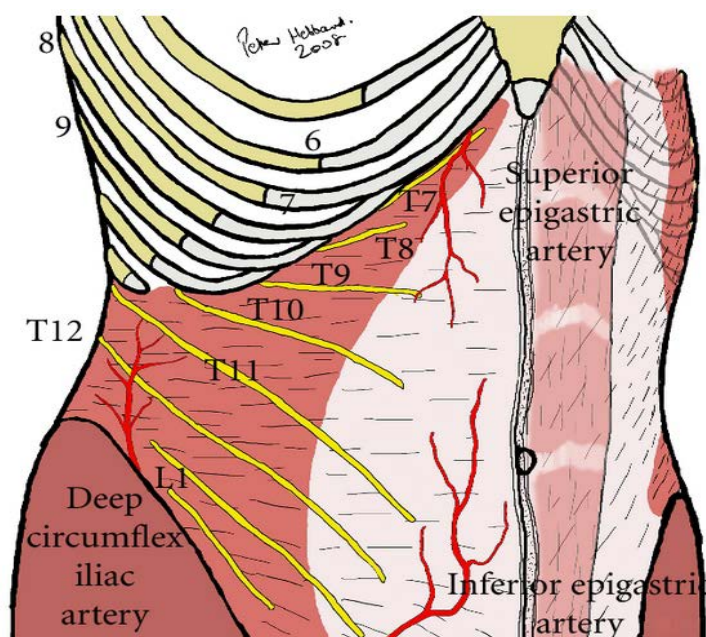


Figure 1. Distribution of nerves in the (TAP) transverse abdominis plane. Generously shared from the personal files of Prof. P. Hebbard.

Table 2. Comparative clinical studies.

Study (Prospective Randomized Control Trial)	Operation	nTAP/ nControl	TAP Block	Anesthetic	Post-Op Analgesia	Effect on Acute Pain Score	Effect on CPOP
Topal <i>et al.</i> [33]	Hernioplasty	40/40/40	Bilateral USG Bupivacaine 20 ml of 0.25%	General Anesthesia and Spinal (12.5 mg Bupivacaine and 0.15 mg Morphine)	Tramadol	Reduced	Reduced
Aveline C <i>et al.</i> [34]	Open Inguinal Hernia Repair	134/139	Bilateral USG Levobupivacaine 1.5 mg/kg of 0.15%	General Anesthesia and/or INH Block	Morphine, Paracetamol, Ketoprofen	Reduced	No Difference
Arora S <i>et al.</i> [35]	Laparoscopic Inguinal Hernia Repair	35/36	Bilateral USG Ropivacaine 15 - 20 ml of 0.5%	General Anesthesia	Fentanyl PCA, Paracetamol	Reduced	No Difference
Amr YM <i>et al.</i> [36]	Hysterectomy	23/23/22	Bilateral Landmark Bupivacaine 20 ml of 0.375%	General Anesthesia	Morphine	Reduced	Reduced
McKeen DM <i>et al.</i> [37]	Cesarean Delivery	41/42	Bilateral USG Ropivacaine 20 ml of 0.25%	General Anesthesia	Naprosyn, Acetaminophen, Oxycodone	No Difference	No Difference
Chandon M <i>et al.</i> [38]	Cesarean Delivery	36/29	Bilateral USG Lepobupivacaine 20 ml of 0.375%	Spinal Anesthesia (Bupivacaine + Sufentanil)	Paracetamol, Ketoprofen, Nefopam, Morphine	n/a	n/a

study; effect of Ultra sound guided TAPB. In hernioplasty on chronic pain, 3 groups were divided including 40 patients in each group with minimum of 6 months passed since the surgery done, Group T patients received TAP block with general anesthesia, Group S received spinal anesthesia and Group G received IV analgesia with general anesthesia. During early post operative pain evaluation no

statistically significant difference was found among the groups ($p > 0.05$). But slightly statistically significant difference was found when the Visual Analogue Score (VAS) of the patients with pain were compared ($p = 0.000$). Whereas while comparing chronic pain, statistically significant difference was found among the groups in terms of chronic pain rates, 47.5% in Group G, 20.0% in Group T and 40.0% in Group S, the p value was 0.030. Development of chronic post operative pain was found lower in Group T compared with Group G ($p = 0.000$) and Group S ($p = 0.003$). However, no any statistically difference were found in VAS, frequency and nature of pain, sleep and daily activities among the patients with chronic pain ($p > 0.05$). It was concluded in the study that TAPB used as combined anesthesia along with general anesthesia can decrease the incidence of chronic post-operative pain. Yet the author recommended further prospective clinical trials due to retrospective nature of the study.

Another study conducted among inguinal hernia repair patients, comparison of TAPB guided by USG and ilioinguinal/iliohypogastric nerve block. 273 Patients were randomly allocated into 2 groups. Both the group received general anesthesia after the nerve blocks. The study showed patient given TAPB had better pain management in immediate postoperative period but comparing the VAS of both groups at 3 and 6 months after surgery at rest and movement, no difference were noted between both the groups. TAP block was found having no any better impact on prevention of chronic post-operative pain in compared to the other method [34]. But the reason may be because both the method follows the similar principle and the nerves to be anesthetized during the TAPB (T7-L1) include both the iliohypogastric and ilioinguinal nerves. Therefore both the group may have the similar impact upon the chronic post-operative pain.

Recent study done by Shubhangi Arora [35] was done by allocating 71 patients randomly to see acute and persistent post-operative chronic pain for patients undergoing laparoscopic inguinal hernia repair using TAPB. Both the group received general anesthesia, whereas one group received bilateral USG TAPB after the induction. Result showed the patients who received TAP Block had reduced pain up to 24 hours after the surgery. As well, less pain complaint was noticed at Week 1 and 3 month in TAP Block group compared with the control group but statistically no difference was noted. It may be due to lesser number of the sample size thus further study was recommended.

Chronic pain after abdominal hysterectomy accounts for 5% - 32% [40]. Study done by Yasser Md [36] on effect of TAP block pre- and post-incisional on acute and chronic pain in patients undergoing hysterectomy, 75 patients were randomized to 3 groups where two groups received TAP block pre-incisional after general anesthesia and before the emergence from general anesthesia whereas one group just received sham block after the general anesthesia where just needle was inserted and no drugs was injected as control group. Post-operative analgesic requirement was significantly decreased in pre-incisional group than the other two groups and also the consumption of morphine was significantly reduced in the ward in the first 48 hours. VAS of pre-incisional TAPB group was significantly

lower than the other two groups. It was also noted the incidence of chronic pain at three and six months was decreased significantly in the pre incisional group in compared with post incisional TAPB group and the control group ($p = 0.035$, 0.029 respectively). 17.4% patients in the control group and 13.6% in the other group were using NSAID as a mode of analgesia and pain control whereas non of the patients in pre-incisional TAPB group used. Hence it was concluded that TAP block as preemptive analgesia before the hysterectomy had better post-operative analgesia and significant reduction in the incidence of chronic post-operative pain.

Cesarean section is one of the common surgery with incidence of chronic post-operative pain which accounts for 18% of patients [41]. Dolores *et al.* [37] conducted a randomized controlled trial including 83 patients undergoing cesarean delivery under spinal anesthesia. After the surgery post operatively patients received 30 mg of ketorolac, 4 mg of ondansetron, acetaminophen 1 gm and bilateral US guided TAP block. The TAP block was randomized into two groups of (0.25% 20 ml ropivacaine) and (0.9% 20 ml Normal Saline) as control group. The result concluded, TAP block failed to improve postoperative pain, reduction in opioids consumptions and chronic post-operative pain.

Similarly, Chandon M. *et al.* [38] conducted a RCT between US guided TAP block and Continuous wound infusion for post-operative analgesia. 80 patients were randomized and after the surgery under subarachnoid block, bilateral US guided TAP block of 20 ml of 0.3755% levobupivacaine or a continuous wound infusion via an elastometric pump delivering 5 ml/hour of 250 mg of levobupivacaine in 200 ml of solution set. Intravenous morphine was optional if the pain score (Verbal response numerical scale) was 4 or higher. There was no significant difference between the two groups in the rates pain during rest or motion and in morphine consumption. Also there was no significant difference in incidence of chronic pain between the two groups.

In different abdominal surgeries, the effect of TAP Block has different effects on chronic post-operative pain. It may be due to the limited sample size of the patients, different surgical methods and different anatomy involved in different kind of surgery. As above studies mentioned, in the case of incisional hernia the effect of block seemed to be pronounced in reduction of chronic post-operative pain whereas in cesarean section there seemed to have no effect. Used as a preemptive analgesia in hysterectomy also showed a significant reduction in incidence of chronic pain. It can be used as a combined anesthesia with general anesthesia or spinal and also could be used as a multimodal analgesia and preemptive analgesia.

7. Complications of TAP Block

Since the development of ultrasound guided technique no organ injuries have been reported while the procedure [42] except one case of liver injury which was said due to the result of excessive depth of penetration due to failure to accurately image the entire needle during the procedure [43]. Farooq *et al.* [44] also reported

a case of liver injury while using the Landmark based technique. There have also been reports of occurrence of intestinal hematoma as well [45]. Local anesthetic systemic toxicity may occur during any procedure of regional anesthesia if the large volume of local anesthetics enters the blood vessels. A case of local anesthetic poisoning in TAP block during Cesarean section was reported [46]. This complication can be avoided by careful aspiration during the procedure. Other complication includes such as intra-peritoneal injection, bowel hematoma, visceral damage and transient femoral nerve palsy [42]. There may be always the possibility of under-reported minor complications as well.

8. Conclusion

Effective management of chronic post-operative pain not only eases the discomfort caused by the pain but also increases the quality of life of the patients. As an anesthetist we need to think the preventive rather than the curative way for the chronic post-operative pain. As there is not any standard way for the treatment of the chronic post-operative pain, but as a preventive way, we can give the patient a better perioperative pain management by choosing the appropriate way of anesthetic procedure, actively dealing with the acute post-operative pain which may eventually help in reduction in the chronic post-operative pain. TAP block used as a multimodal analgesia and combined anesthesia may have a positive effect on reduction in incidence of chronic post-operative pain and can also be a good alternative for patients, highly sensitive to opioids. It also has a high margin of safety and is technically easy to perform, especially under guidance of ultrasound. Its uses in variety of abdominal procedures can be taken as a benefit for its usage. TAP block also can be used as a pre-emptive analgesia for the reduction of central sensitization which has an impact on chronic post-operative pain. The procedures' ability to reduce opioids consumption, improve reduction of acute pain eventually leading to decrease in chronic post-operative pain can lead a greater patient satisfaction. However, still further studies and clinical trials with larger sample sizes and different subjects need to be conducted in different kinds of surgeries.

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Abbreviation

Chronic Post-Operative Pain—CPOP

Transverse Abdominis Plane Block—TAPB

International Association for the Study of Pain—IASP

Central Sensitization—CS

Nitric Oxide—NO

Randomized Control Trials—RCT

Visual Analogue Scale—VAS

Ultra Sound Guided—USG



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