Academic Journal of Clinicians
International Peer Reviewed Journal
ISSN: Print: 2959-90- Online: 2959-9016

Comparison of Patient-Controlled Analgesia (PCA) and Transversus Abdominis Plane (TAP) Block for Postoperative Pain Control in Patients Undergoing Abdominoplasty

Hevy Sherko Fathulla[1]*, Bnar Halko Ahmad Shawq[2], Hozan Abdulwahid Ahmed[3] Alan Ihsan Ferhadi [4]

ABSTRACT

Background: *Postoperative pain management is major priority for the surgeon and patients , so adequate pain control and choosing the correct method makes patient more stable .*

Aim of study: *To compare the effectiveness of TAP block and PCA for postoperative pain control for patients undergoing abdominoplasty .*

Patient and method

A prospective comparative study conducted during the year 2023 and included 30 cases undergoing abdominoplasty in Par Private hospital. Patients were assigned into two equal groups to be managed by either PCA or TAP block. Written informed consent was obtained for each case and all ethical issues were taken into account and approved by the authors.

Result: *Both groups were almost matched for age , weight and ASA class, (P.>0.05). Systolic and diastolic blood pressure, mean arterial pressure and heart rate were significantly lowered in PCA group compared to TAP block group, (P<0.05). Pain score was significantly lowered in both groups. It was more significant and lower in PCA than TAP block group (P<0.05).*

Conclusion: *Tap block and PCA both are efficient in relieving postoperative pain but dose and ways are different for each one. Each modality have its benefit and pitfall, so none of these two modalities is superior to other.*

Keywords *: Abdominoplasty, Postoperative pain, management, Patient-Controlled Analgesia (PCA) Transversus Abdominis Plane (TAP) block*

Authors' Information

1.M.B.Ch.B, FICMS, Senior Specialist in Anesthesia & Interventional Pain Management Rizgary Hospital , Erbil, KRI, Iraq. drhevysherko@gmail.com

2. M.B.Ch.B, FICMS, FIPP, Senior Specialist in Anesthesia & Interventional Pain Management, Head of Pain Management Unit, Rizgary Hospital , Erbil, KRI, IRAQ. drbnar@yahoo.com

3.M.B.Ch.B,KBMS, Senior Specialist in Anesthesia & Intensive Care, Manager of Planning in DOH hozanahmed87@gmail.com

4. Specialist in plastic surgery, Rojawa Emergency hospital , Erbil, KRI, Iraq. dr.alanplastic@gmail.com

Article Information:

Original Article

Submitted: October, 2023 Received in revised: November 2023, Published: December 2023

INTRODUCTION:

Nowadays, body shape represents an important factor both from an aesthetic and health point of view. Abdominoplasty, with or without the addition of liposuction, is one of the most commonly carried out cosmetic surgeries. The primary goal is to enhance the body's shape by surgically removing excess skin and fatty tissue. While abdominoplasty is generally regarded as a safe procedure with high rates of patient satisfaction, the surgical team may encounter challenges due to problems that arise during or after the operation [(1)].

In 2019, the Aesthetic Plastic Surgery National Databank reported that abdominoplasty ranked as the fourth most prevalent cosmetic surgical procedure in the United States, with a total of over 140,000 surgeries completed . Patients typically pursue abdominoplasty to address issues such as laxity in the abdominal wall, excessive skin, stretch marks, or separation of the rectus muscles. Abdominoplasty is not recommended in cases where there are scars in the upper quadrant of the abdomen. Other relative contraindications include severe medical conditions such as heart disease, diabetes, morbid obesity, and cigarette smoking. It is also not recommended for women who are planning to become pregnant in the near future, have a history of thromboembolic disease, or have a body mass index (BMI) higher than 40 (indicating morbid obesity). Unrealistic patient expectations are also considered a contraindication. Different complications are associated with abdominoplasty ranging from simple negligible to serious complications; [(1–3)]

Nerve damage commonly occur as a result of the dissection involved in lifting the abdominal flap [(4)]. Although it is rare, deep vein thrombosis (DVT) can occur . Additionally, pain triggers a series of events leading to the production and release of inflammatory mediators including prostaglandins and leukotrienes, along with an endocrine and metabolic reaction. As a result, the release of hormones causes detrimental effects on many tissues, leading to an escalation in patient morbidity and mortality rates, as well as impeding the recovery process. Furthermore, this could potentially have significant consequences for the patient's psychological well-being . Insufficient management of pain before and after surgery, might worsen outcomes of abdominoplasty and also increase the risk of complications. To effectively manage patients' expectations and minimize the risk of adverse consequences or inadequate pain control, it is crucial to have a full understanding of the various therapeutic techniques, their indications, and potential risks [(5,6)].

Over the past two decades, there have been significant advancements in the understanding of postsurgical pain, as well as in the field of pharmacology and the management of postoperative pain. Patient-controlled analgesia (PCA) first introduced in 1965 for adults and later in pediatric population in the late 1980s. Since its introduction PCA has undergone continuous development and now serves as an unquestionable benchmark and treatment standard [(7)]. PCA has several benefits compared to conventional opioids, many literatures and randomized clinical trials have shown that PCA was better than other methods as postoperative analgesia where it improved significantly the satisfaction of patients and reduced the pain scores, help to address the significant variations in pain and analgesic requirements among individuals and reduces the period between pain onset and relief. Additionally, most studies documented a favorable safety profile for PCA[(8,9)]

The concept of PCA has been derived from many therapeutic approaches, depending on the context of acute postoperative pain, chronic pain, pain associated with obstetric labor, or, in specific instances, sedation for brief surgical or diagnostic procedures in certain outpatient treatments. An ideal PCA modality should possess certain criteria. Firstly, it should be adaptable to all analgesia requirements, primarily postoperative but not limited to it. Secondly, it should utilize medicinal agents that provide optimal efficacy and safety profiles. Thirdly, it should minimize instances of inadequate analgesia. Fourthly, it should be user-friendly for both patients and healthcare professionals. Furthermore, it should result in a high level of patient satisfaction and not interfere with other forms of care, and should not impede patient mobility [(10)]. The practical application of the PCA principle was long based on postoperative intravenous analgesia with morphine; Subsequently, other routes have been widely developed, subcutaneous or loco-regional, central and peripheral, as well as for the treatment of certain chronic painful pathologies [(11)]. However, the intravenous route is the most frequently used and the oldest PCA modality in the postoperative setting. In chronic pain, PCA seems to be an effective tool to treat some chronic pain syndromes, whether it is pain of cancer origin [92] or not (neuropathic pain, oropharyngeal mucositis). Although, it is a safe technique, some adverse effects and complications might associated with PCA; often reported consequences include nausea, vomiting, itching, respiratory depression, sedation, disorientation, and urine retention. Nevertheless, the prevalence of these issues can also be attributed to human factors such as pharmacy preparation and device programming, whereas device failure is significantly less problematic. [12,13]

The transversus abdominis plane (TAP) block has recently gained recognition as a reliable approach for postoperative multimodal analgesia throughout the past decade. It was first described by Rafi in 2001, since that time TAP block has undergone advancements in response to the growing utilization of ultrasound and improved comprehension of anatomy. These developments have resulted in the creation of different sub-blocks that specifically target certain abdominal dermatomes [14].

Due to the great advancements in ultrasound-guided regional anesthesia techniques, TAP Block have become increasingly useful and relevant. Currently, TAP Block considered an alternative to neuraxial central regional anesthesia techniques and are also used as a supplement in postoperative multimodal analgesia. Ultrasound is employed to enhance the safety, efficacy, and complication rates of anesthetic blocks. Internationally, numerous research studies have explored the use of local anesthetic injection in the transversus abdominis plane to effectively control postoperative pain associated with lower abdominal procedures, including prostatectomy, hernioplasties, appendectomies, hysterectomies, and cesarean sections [15–18].

However, surgeons and anesthesiologists' often focus on postoperative pain management and the optimal method or procedure to control postoperative pain and increase the patients' satisfaction, therefore, the objective of our study is to assess the efficacy of TAP block and PCA in management of postoperative pain among patients undergoing abdominoplasty

PATIENTS AND METHODS:

This was a prospective comparative study conducted at Par Private Hospital in 2023 including a total of 30 patients who were undergoing abdominoplasty. Patients were assigned into two equal groups according to the pain management method; first group included 15 patients who were managed with PCA, namely PCA group. The second group included the remaining 15 patients in whom TAP block was used, namely TAP block group.

The study included a total of 30 patients aged 18-60 years of both genders and they were at class I or II ASA according to the statement of the American Society of Anesthesiologists for the physical status classification system [19].

We excluded patients who had one or more of the following:

Dementia; Alzheimer's disease; depression; persistent/chronic pain; allergy to any anesthetic agent; smoker; cardiovascular diseases and respiratory problems

Operative protocol

All operations (abdominoplasty) were performed by the same surgeon (Dr. Alan Ihsan Ferhadi) plastic surgeon at Par Private Hospital

After we had a case in the theater a 20 gauge cannula was inserted. All operations were performed under general anesthesia in both groups using standard protocols for general anesthesia and anesthetic agents that implemented in our hospital.

Vital signs were monitored intraoperatively until the end of operation and were reported

TAP block

TAP block performed under aseptic conditions using US to find muscles of abdomen. Injection was at the T10 dermatome level providing nerve block to lower abdomen. Injection was performed in the plane between transversus abdominis and internal oblique muscles.

Medication: a 40 ml of lidocaine 0.1% for both sides. Lidocaine 1mg\kg plus 0.5% bupivacaine 1mg\kg with 10 ml normal saline for testing . Then patient extubated and transferred to the recovery room.

PCA

PCA was administered after extubation directly through iv line

Pain Assessment and scoring:

Postoperative pain intensity was assessed and scored using the visual analogue scale (VAS) which is consisted of 10 cm line with two end points; the zero end point represents no pain and the 10 end point represents the worst pain as bad as it can be[20].

Postoperative Nausea and vomiting (PONV) assessment:

Postoperative Nausea and vomiting (PONV) rated on a grading scale of 0 to 3, where 0 represents absent N&V, 1: mild which is not required treatment, 2 moderate; treatment is needed and 3 the severe N&V which is not respond to treatment[20].

Subsequent assessment:

Vital signs , pain intensity, nausea and vomiting were recorded at 1,2,4, 6 and 12 hours. Bowel sounds and bowel motion were checked regularly and the timing was reported.

Need for extra medicines use like ondasteron or placil or any extra pain killer.

Mean arterial pressure (MAP) was calculated the product of 2DBP + SBP divided by 3, according to the following standard equation [21]:

$$\mathrm{MAP} = \frac{2 \text{ x } \mathrm{DBP} + \mathrm{SBP}}{3}$$

Analysis of Data: It was conducted using the statistical software package for social sciences (SPSS) version 28. Variables were expressed as mean, standard deviation and range. Repeated measure ANOVA was applied to compare the mean values across the subsequent measurement time within each group. Student's t test applied to compare mean values between groups for scale variables. Bivariate correlation analysis was performed to assess the possible effect of age and weight of the patients on the changes in the vital signs, pain scores and nausea and vomiting. Pearson's correlation coefficient (R) was calculated which is a statistical value ranged between 0 (complete no correlation) and one (perfect correlation) and the higher R value close to one indicates the stronger correlation. All statistical tests and procedures were conducted with a significance level (P-value) of 0.05 or below to determine significance.

RESULTS:

A total of 30 patients were equally assigned onto the two study groups; PCA and TAP block group. Both groups were not significantly different regarding their age and weight, (P. value >0.05), (Table 1).

Comparison of vital signs systolic blood pressure (SBP), diastolic blood pressure (DBP), Mean arterial pressure (MAP) , Heart rates and pain scores between the studied groups are demonstrated in (Tables 2 – 6). It had been observed that SBP was significantly higher in PCA group than TAP block group at one hour, more significantly lowered in PCA group while not in TAP block group where it was almost stable but it was increased at the 12th hour. However, at the 2 hours and 4 hours the difference between groups in SBP was statistically not significant, (P>0.05). similar to the SBP trend of change, DBP , MAP and heart rates were significantly reduced with the time in PCA group, (P<0.05). while no significant change in TAP block group, (P>0.05).

The mean time of bowel motion was significantly longer in PCA than in TAP block group, the mean time was 11.5 ± 1.7 vs. 10.1± 1.0, respectively, (P<0.05), (Table 7).

We further assessed the possible effect of the patient's age and weight on the changes in the vital signs and the incidence of N&V using bivariate correlation analysis which revealed no significant correlation between age and weight of the patient from one side against changes in vital signs and frequency of N & V from the other side, in all comparisons, (P>0.05)m (Table 8).

It is worth mentioned that we sid not reported nausea and vomiting in our patients and additional medications that required were not significantly different between both groups. However, some patients needed traditional analgesics like paracetamol, voltarine and Pethidine on the second or third day postoperatively. No failure of either procedure was reported in our study.

Table 1. Age and weight distribution of the studied groups

Variable	Group				P. value
	PCA (n=15)		TAP block (n=15)		
	Mean	SD	Mean	SD	
Age	34.4	9.8	40.8	10.7	0.683 ns
Weight	80.9	9.5	78.5	9.6	0.485 ns

SD: standard deviation, sig: significant, ns: not significant

Table 2. Comparison of systolic blood pressure of the studied groups at different follow up time

Follow up time	Group				P. value between groups
	PCA (n=15)		TAP block (n=15)		
	Mean	SD	Mean	SD	
One hour	149.5	20.8	121.5	21.3	0.001 sig
Two hours	133.9	20.0	122.9	20.8	0.149 ns
Four hours	115.7	13.2	127.0	18.4	0.062 ns
Six hours	104.0	11.0	129.5	23.7	0.001 sig
Twelve hours	102.2	6.6	132.4	20.0	<0.001 sig

P. value within group	<0.001 sig		0.042 sig		

SD: standard deviation, sig: significant, ns: not significant

Table 3. Comparison of diastolic blood pressure of the studied groups at different follow up time

Follow up time	Group				P. value between groups
	PCA (n=15)		TAP block (n=15)		
	Mean	SD	Mean	SD	
One hour	86.1	12.2	72.9	13.7	0.009 sig
Two hours	75.9	9.8	75.4	11.9	0.908 ns
Four hours	69.3	8.9	77.2	11.6	0.045 sig
Six hours	67.7	7.6	79.5	12.7	0.005 sig
Twelve hours	59.9	8.6	77.7	10.2	<0.001 sig
P. value within group	<0.001 sig		0.574 ns		

SD: standard deviation, sig: significant, ns: not significant

Table 4. Comparison of mean arterial pressure of the studied groups at different follow up time

Follow up time	Group				P. value between groups
	PCA (n=15)		TAP block (n=15)		
	Mean	SD	Mean	SD	
One hour	107.3	12.4	89.1	14.9	0.001 sig
Two hours	95.2	11.6	91.2	13.2	0.385 ns
Four hours	84.7	8.8	93.8	12.7	0.031 sig
Six hours	79.8	5.5	96.2	15.1	<0.001 sig
Twelve hours	73.4	8.4	95.9	12.4	<0.001 sig
P. value within group	<0.001 sig		0.306 ns		

SD: standard deviation, sig: significant, ns: not significant

Table 5. Comparison of heart rates of the studied groups at different follow up time

Follow up time	Group				P. value between groups
	PCA (n=15)		TAP block (n=15)		
	Mean	SD	Mean	SD	
One hour	97.2	7.1	86.5	13.4	0.010 sig
Two hours	82.9	7.2	85.1	10.5	0.509
Four hours	74.0	6.9	84.1	13.1	0.014 sig
Six hours	66.3	5.9	84.6	8.9	<0.001 sig
Twelve hours	65.9	4.8	83.5	7.5	<0.001 sig
P. value within group	<0.001 sig		0.662 ns		

SD: standard deviation, sig: significant, ns: not significant

Table 6. Comparison of Pain score of the studied groups at different follow up time

Follow up time	Group				P. value between groups
	PCA (n=15)		TAP block (n=15)		
	Mean	SD	Mean	SD	
One hour	5.2	2.1	3.5	2.3	0.049 sig
Two hours	2.5	1.4	3.6	1.9	0.038 sig
Four hours	1.9	1.5	3.4	1.5	0.007 sig
Six hours	1.5	1.5	3.3	1.5	0.003 sig
Twelve hours	1.5	1.6	3.8	1.6	<0.001 sig
P. value within group	0.004 sig		0.273 ns		

SD: standard deviation, sig: significant, ns: not significant

Table 7. Comparison of Time of bowel motion of the studied groups

	Group		P. value
Time of bowel motion (hour)	PCA (n=15)	TAP block (n=15)	
Mean	11.5	10.1	**0.009 sig**
SD	1.7	1.0	
Range	9 - 17	9 - 15	

SD: standard deviation

Table 8. Results of bivariate correlation analysis for the changes in vital signs and incidence of nausea and vomiting (N&V) as dependent variables with age and weight of the patients as independent variables

Dependent variables	Correlation parameters (independent variables)			
	Age		Weight	
	R	P. value	R	P. value
Change in DBP	0.132	0.486	-0.238	0.206
Change in SBP	-0.044	0.819	-0.049	0.798
Change in MAP	-0.039	0.839	0.142	0.453
Change in HR	0.090	0.637	-0.248	0.186
Change in Pain scores	-0.016	0.935	0.204	0.279
Incidence of N&V	0.026	0.892	-0.210	0.266

R: correlation coefficient

Discussion:

Efficient management of pain after surgery decreases surgical stress and directly impacts the occurrence of complications. Moreover, early patient movement and pain management contribute to the prevention of respiratory depression, thereby positively impacting postoperative respiratory functioning. While numerous studies have suggested the potential of TAP block to alleviate postoperative pain following lower abdominal surgery[22]. A systematic review conducted by Cahrlton et al. [23] concluded that the effectiveness of TAP block is controversial and there are limited data available about its effect on pain scores. Furthermore, Erbabacan et al. [22] stated that studies that compare the efficacy of TAP block with alternative pain management techniques are scarce. In our country, particularly Kurdistan region we did not find any study comparing the analgesic effect of PCA and TAP block. Therefore, we aimed in this study to compare the effectiveness of TAP block and PCA in controlling postoperative pain in patients undergoing abdominoplasty. Hence we included 30 patients to whom abdominoplasty was performed in Par Private Hospital. For quality control and to avoid any possible bias or confounding effect we tried to match the studied group and randomly assigned them on each arm of the study. Matching is necessary in comparative studies as it is recommended by epidemiologists and clinical researches designer [24]

In general, we found that PCA group had significantly higher SBP than TAP block group at one hour, but it was more significantly lowered at the next hours while no similar change reported in TAP block group where SBP was almost stable and then increased at the 12th hour. At the 2 hours and 4 hours the difference between PCA and TAP block groups was statistically insignificant, (P>0.05). Almost similar trend of change in DBP, MAP and heart rates which were significantly reduced with the time in PCA group. According to these findings we can stated that the vital signs seemed to be more stable in TAP block than PCA group. The lower blood pressure in PCA group could be attributed to more vasodilation effect of the analgesic agents in PCA group . On the other hand, the observed disparity in heart rates did not have any meaningful impact on clinical outcomes.

However, other studies documented almost similar findings; Ban Leong Sng et al. [25] reported that all patients who received intravenous opioid had at least one episode of lower heart rate < 60 /min for 60 seconds and five of them had persisted low heart rate for longer than 60 seconds. With regard to the significant lower SBP, DBP and MAP in PCA group particularly at 4, 6 and 12 hours which might favour TAP block. However, our findings must be carefully interpreted when we take into account the small sample size in our study. Nonetheless, our findings were consistent with that reported by Jeong et al. [26]

We found that pain scores were significantly lower in PCA group at each assessment time; 1, 2,4,6 and 12 hours where in PCA group the mean pain score was 5.2 and reduced to 2.5, 1.9 and 1.5 at the subsequent hours, in TAP block group despite the lower pain score at one hour, (mean score = 3.5) but it still almost the same at the subsequent hours ranging between 3.3 – 3.8, so that no significant reduction was observed like that in PCA group.

Peterson et al.[27] used ultrasound guided TAP block postoperatively, in comparison to local anaesthetic infiltrations and both of these groups were compared to placebo group. Sivapruapu et al.[27] in their study performed TAP block in addition to Morphine PCA in one group of patients during gynaecological lower abdominal procedures and compared them with infiltration group, they found that TAP block effectively reduces surgical pain and decreases the requirement for further narcotics.

Erbabacan et al.[22] compared the TAP block vs. PCA in lower abdominal surgeries among 74 patients aged 18 – 80 years undergoing lower abdominal surgery and concluded that the efficacy of transversus abdominis plane block is comparable to that of intravenous morphine-PCA for the post-operative pain management among patients undergoing lower abdominal surgeries when administered in a volume of 30 milliliters. IV-PCA may be less desirable compared to alternative methods, as it exhibits a delayed onset of analgesic action and increases the overall impact of morphine on the body

Moreover, Peterson et al.[27] concluded that VAS scores were significantly higher in TAP block compared to infiltration group while not significantly different than placebo group.

In 2022 in a meta-analysis included 22 clinical trials and 1975 patients who were underwent abdominal surgery , Jeong et al. [26] from Republic of Korea, compared TAP block against patient-controlled epidural analgesia and did not identify any substantial or medically significant disparity in the postoperative pain ratings until 72 hours following the surgical procedure. Jeong et al. suggested that both approaches yield comparable efficacy in terms of pain scores. They also revealed that TAP block group had a significantly shorter time to ambulation and a significantly lower incidence of hypotension compared to the TEA group. In relation to these results, the TAP block may be a more favorable option compared to TEA. Nevertheless, that meta-analysis recommended that including more studies would not reveal any significant difference in pain scores between these two techniques that would be clinically meaningful.

In contrast, Sharma et al. [28] compared Tramadol PCA against combined TAP block and PCA . Their findings indicated that patients who underwent TAP block had lower VAS values compared to those who did not underwent TAP block.

As the TAP block was administered prior to extubation, its impact started during the patient's recovery phase. Patients who received TAP block experienced a smoother and pain-free awakening due to the absence of narcotic usage for postoperative pain control. We hypothesize that this phenomenon hindered the restriction of breathing due to pain, resulting in higher SpO2 levels compared to the PCA group .

It has been proposed that preoperative administration of TAP block significantly reduces the intraoperative use of opioids. Nevertheless, administration of a TAP block post-surgery was preferred by some authors because they discovered that administering a preoperative TAP block, particularly in high doses, hindered the surgeon's ability to identify the anatomy and resulted in longer surgical durations for abdominal procedures [18,29–31].

Regarding the nausea and vomiting, we did not found a significant difference in their incidence among both groups; where none of the patients in PCA group and only two patients in TAP block group developed nausea and vomiting. Conversely, Sivapurapu et al.[32] documented higher frequency of nausea and vomiting in PCA group. The increased amount of nausea and vomiting observed in the PCA group can be attributed to the emetic properties of tramadol administered prior to extubation in Sivapurapu’s study [32].

The mean time of bowel motion was significantly longer in PCA than in TAP block group, we further assessed the possible effect of the patient’s age and weight on the changes in the vital signs and the incidence of N&V using bivariate correlation analysis which revealed no significant effect for age and weight of the patient on the changes in vital signs and frequency of N & V. However, some patients needed traditional analgesics like paracetamol, voltarine and Pethidine on the second or third day postoperatively. No failure of either procedure was reported in our study. A limitation in our study is that the individuals who assessed and the patients themselves were not kept unaware to the treatment methods used, as the TAP block and PCA procedures employed were distinct.

CONCLUSION:

Tap block and PCA both are efficient in relieving postoperative pain but they are different in dose , technique and preferences of patients. Each modality has its benefit and pitfall, so none of these two modalities is superior to other.

BIBLIOGRAPHY

1. Vidal P, Berner JE, Will PA. Managing Complications in Abdominoplasty: A Literature Review. Arch Plast Surg. 2017 Sep;44(5):457–68.
2. Rosenfield LK, Davis CR. Evidence-based abdominoplasty review with body contouring algorithm. Aesthetic Surg J. 2019;39(6):643–61.
3. Blugerman G, Schavelzon D, Martínez B, Wexler G, Markowsky A, Lotoki M. New concepts on safer abdominoplasty. Body contouring Sculpt London Intech Open. 2016;93–108.
4. Ducic I, Zakaria HM, Felder III JM, Arnspiger S. Abdominoplasty-Related Nerve Injuries: Systematic Review and Treatment Options. Aesthetic Surg J [Internet]. 2014 Feb 1;34(2):284–97. Available from: https://doi.org/10.1177/1090820X13516341
5. Valero EG, Vargas F, Guio YD, Andrade M, Zúñiga MA, Alvarez E, et al. Perioperative pain management in abdominoplasty. Rev Chil Anest. 2023;52(7):688–96.
6. Joshi GP, Ogunnaike BO. Consequences of inadequate postoperative pain relief and chronic persistent postoperative pain. Anesthesiol Clin North America. 2005 Mar;23(1):21–36.
7. Kattail D. Patient-controlled analgesia. Open Anesth. 2023;4(4):1–6.
8. Walker BJ, Polaner DM, Berde CB. Acute Pain. In: Coté CJ, Lerman J, Anderson BJ. Coté and Lerman's a practice of anesthesia for infants and children (6th edition). Philadelphia, PA: Elsevier; 2018: 1023-62.
9. McNicol ED, Ferguson MC, Hudcova J. Patient controlled opioid analgesia versus non-patient controlled opioid analgesia for postoperative pain. Cochrane database Syst Rev. 2015 Jun;2015(6):CD003348.
10. Nardi-Hiebl S, Eberhart LHJ, Gehling M, Koch T, Schlesinger T, Kranke P. A review on current concepts, economic considerations, patient-related aspects, and future development with respect to patient-controlled analgesia. Anesthesiol Res Pract. 2020;2020.
11. Baboli KM, Liu H, Poggio JL. Opioid-free postoperative analgesia: Is it feasible? Curr Probl Surg [Internet]. 2020;57(7):100794. Available from: https://www.sciencedirect.com/science/article/pii/S0011384020300642
12. Lehmann KA. Recent Developments in Patient-Controlled Analgesia. J Pain Symptom Manage [Internet]. 2005;29(5, Supplement):72–89. Available from: https://www.sciencedirect.com/science/article/pii/S088539240500031X

13. Motamed C. Clinical update on patient-controlled analgesia for acute postoperative pain. Pharmacy. 2022;10(1):22.
14. Mallan D, Sharan S, Saxena S, Singh TK, Faisal. Anesthetic techniques: focus on transversus abdominis plane (TAP) blocks. Local Reg Anesth. 2019;81–8.
15. Young MJ, Gorlin AW, Modest VE, Quraishi SA. Clinical implications of the transversus abdominis plane block in adults. Anesthesiol Res Pract. 2012;2012:731645.
16. Rautela MS, Sahni A, Dalal N. Is Ultrasound-Guided Transversus Abdominis Plane Block Superior to a Caudal Epidural or Wound Infiltration for Intraoperative and Postoperative Analgesia in Children Undergoing Unilateral Infraumbilical Surgery? A Double-blind Randomized Trial. J Indian Assoc Pediatr Surg. 2022;27(3):323–8.
17. Mahmoud WA, Omar MMM, Ahmed IM, EL Khayat HMH. Transversus Abdominis Plane (TAP) Block. Egypt J Hosp Med. 2022;86(1):898–901.
18. Cribben N, McDonnell J. Transversus Abdominis Plane Blocks. In: Regional Nerve Blocks in Anesthesia and Pain Therapy: Imaging-guided and Traditional Techniques. Springer; 2022. p. 457–66.
19. Knuf KM, Maani C V, Cummings AK. Clinical agreement in the American Society of Anesthesiologists physical status classification. Perioper Med. 2018;7(1):1–6.
20. Shafshak TS, Elnemr R. The visual analogue scale versus numerical rating scale in measuring pain severity and predicting disability in low back pain. JCR J Clin Rheumatol. 2021;27(7):282–5.
21. DeMers D, Wachs D. Physiology, mean arterial pressure: A Study Guide. StatPearls Publ PMID. 2019;30855814.
22. Erbabacan E, Kendigelen P, Köksal GM, Tütüncü Ç, Ekici BB, Şeker TB, et al. Comparison of Transversus Abdominis Plane Block and IV Patient-Controlled Analgesia after Lower Abdominal Surgery. Turkish J Anaesthesiol Reanim. 2015 Feb;43(1):24–8.
23. Charlton S, Cyna AM, Middleton P, Griffiths JD. Perioperative transversus abdominis plane (TAP) blocks for analgesia after abdominal surgery. Cochrane Database Syst Rev. 2010;(12).
24. De Graaf MA, Jager KJ, Zoccali C, Dekker FW. Matching, an appealing method to avoid confounding? Nephron - Clin Pract. 2011;118(4):315–8.
25. Sng BL, Tan DJ, Tan CW, Han NLR, Sultana R, Sia ATH. A preliminary assessment of vital-signs-integrated patient-assisted intravenous opioid analgesia (VPIA) for postsurgical pain. BMC Anesthesiol [Internet]. 2020;20(1):145. Available from: https://doi.org/10.1186/s12871-020-01060-4
26. Jeong YH, Jung JY, Cho H, Yoon HK, Yang SM, Lee HJ, et al. Transverse abdominis plane block compared with patient-controlled epidural analgesia following abdominal surgery: a meta-analysis and trial sequential analysis. Sci Rep [Internet]. 2022;12(1):20606. Available from: https://doi.org/10.1038/s41598-022-25073-w
27. Petersen PL, Mathiesen O, Stjernholm P, Kristiansen VB, Torup H, Hansen EG, et al. The effect of transversus abdominis plane block or local anaesthetic infiltration in inguinal hernia repair: a randomised clinical trial. Eur J Anaesthesiol EJA. 2013;30(7):415–21.
28. Sharma P, Saxena A, Bansal R, Mittal A, Shrivastava U. Evaluation of postoperative analgesic efficacy of transversus abdominis plane block after abdominal surgery: A comparative study. J Nat Sci Biol Med. 2013;4(1):177.

29. Kalu R, Boateng P, Carrier L, Garzon J, Tang A, Reickert C, et al. Effect of preoperative versus postoperative use of transversus abdominis plane block with plain 0.25 % bupivacaine on postoperative opioid use: a retrospective study. BMC Anesthesiol [Internet]. 2021;21(1):114. Available from: https://doi.org/10.1186/s12871-021-01333-6
30. De Oliveira GSJ, Castro-Alves LJ, Nader A, Kendall MC, McCarthy RJ. Transversus Abdominis Plane Block to Ameliorate Postoperative Pain Outcomes After Laparoscopic Surgery: A Meta-Analysis of Randomized Controlled Trials. Anesth Analg [Internet]. 2014;118(2). Available from: https://journals.lww.com/anesthesia-analgesia/fulltext/2014/02000/transversus_abdominis_plane_block_to_ameliorate.28.aspx
31. Chen CK, Tan PCS, Phui VE, Teo SC. A comparison of analgesic efficacy between oblique subcostal transversus abdominis plane block and intravenous morphine for laparascopic cholecystectomy. A prospective randomized controlled trial. Korean J Anesthesiol. 2013;64(6):511–6.
32. Sivapurapu V, Vasudevan A, Gupta S, Badhe AS. Comparison of analgesic efficacy of transversus abdominis plane block with direct infiltration of local anesthetic into surgical incision in lower abdominal gynecological surgeries. J Anaesthesiol Clin Pharmacol. 2013;29(1):71.