Original Article

Comparison of continuous preperitoneal infiltration versus patient controlled analgesia for pain control in elective colorectal surgery

ABSTRACT

Background: Post-operative analgesia is crucial in enhanced recovery after surgery and to minimize post-operative complications. There remains data paucity on the efficacy of preperitoneal analgesia (PPA) compared to patient-controlled analgesia (PCA). This study aims to examine the efficacy of preperitoneal infusion as analgesia following elective colorectal surgery.

Methods: This is a prospective cross-sectional study of all patients which underwent elective colorectal surgeries, performed in a tertiary surgical referral center with dedicated colorectal unit. Patients from May 2017 to April 2021 who underwent elective colorectal surgery were included in this study. Pain scores were reviewed and analyzed at regular intervals post-operatively for comparison.

Results: Amongst the 200 patients included, there were 174 patients in the PPA arm and 26 patients using PCA. Patients in the PPA group were older age (63.29 vs 56.00, $P = 0.003$). A total of 118 patients in PPA cohort (67.8%) and 21 from PCA cohort (80.8%) underwent open surgery and the remaining 82 patients underwent laparoscopic surgeries. Although postoperative pain scores were consistently below 5 and reduced in trend from 2 hours to 96 hours postoperatively in both groups, the pain scores on coughing markedly reduced in the PPA group when compared PCA alone. The total dosage of opioid required in PPA cohort was also significantly lower when compared to PCA group at the first 24 hours postoperatively 12.21 (±13.0) vs 20.0 (±14.43), $P = 0.048$.

Conclusions: PPA is a comparable modality for analgesia after elective colorectal surgery that reduces the opioid requirement postoperatively giving adequate pain relief. PPA should be considered as an alternative modality for multi-modal analgesia.

Key words: Colorectal surgery, enhanced recovery after surgery, patient-controlled analgesia, post-operative analgesia, preperitoneal analgesia

Introduction

In line with perioperative concept of enhanced recovery after surgery (ERAS) following elective colorectal surgery, multiple analgesic modalities were developed to improve pain control. Conventionally, epidural analgesia is a widely

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Ng Li Hwee, Teh Jin Zhe, Tan Jih Huei, Henry Tan Chor Lip, Elyaraitul Nadia Bt Rahim, Ivan Ho Khor Ee, Hanis Maisarah Ismail, Raymond Lim Zhun Ming, Jothinathan Muniandy, Chan Koon Khee, Tan Lin Jun[1], Omar Sulaiman[1]

Departments of General Surgery and [1]Anesthesiology, Hospital Sultanah Aminah, Johor Bahru, Malaysia

Address for correspondence: Dr. Tan Jih Huei, General Surgeon, Hospital Sultanah Aminah, Johor Bahru, Malaysia.
E-mail: huei_87@hotmail.com

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accepted regional anesthetic technique for post-operative pain relief used concomitantly with parenteral opioids. Recent advancements and introduction of regional nerve blocks that includes transversus abdominis plane (TAP) block and wound catheter infiltration at preperitoneal, intraperitoneal or subcutaneous plane have seen an increase in its usage.[1-3] However, undesirable complications of epidural nerve block of epidural hematoma, hypotension and post spinal headache has been reported. Furthermore, practical disadvantages of epidural analgesia such as technical expertise requirement, wall attached infusion pump and incomplete sensory or excessive motor blockage, had resulted in a shift in preference towards more localized delivery of analgesia to the muscle or preperitoneal plane blocks.[1]

For a successful transverses abdominis (TAP) plane block, it requires ultrasound guidance for accurate placement of infusion catheters. Comparing to TAP block, preperitoneal catheters are easily implanted under direct vision by the surgeon intraoperatively without the usage of additional imaging modalities. Previous experience in 64 patients from a local colorectal unit revealed good pain control following elective colorectal surgery and the technique has shown no major adverse effect aside from one standalone case of over blockade resulting in thigh numbness.[3] Although there were many English literatures reporting on acceptable efficacy of preperitoneal analgesia (PPA),[2,4] there were minimal number of studies that reported otherwise.[5,6] As the delivery devices for continuous infusion at wound comes with additional costs and previous study by Huei *et al*.[3] had a rather low sample size which did not include a comparison arm; this study is improvised to examine the efficacy of preperitoneal infusion for pain control following elective colorectal surgery.

Method

This study is a prospective evaluation of the use of PPA in the colorectal surgery unit, Hospital Sultanah Aminah from May 2017 to April 2021. All patients that underwent elective colorectal surgery that were performed via open or laparoscopic techniques were included in this study. Demographic data of age, weight, BMI, gender, ethnicity, ASA score and surgery type were compared between the two arms of PPA and patient controlled analgesia (PCA).

In the PPA arm, two 15 cm (19 gauge) multiholed soaker catheters were inserted into the preperitoneal plane on both sides of the surgical incision prior to abdominal closure using an introducer peel-away needle under direct vision at the end of surgery. Following successful insertion, 10 mls of bolus bupivacaine 0.25% was administered via each catheter. Subsequently, a portable elastomeric pump was used to deliver bupivacaine 0.25% through two soaker catheters at a preset flow rate of 2 ml/hour on each side. The evenly placed laterally aligned holes along the lengths of the catheter allowed equal distribution of local anesthesia over a wide area of the incision site over 4 to 5 days.

After the surgery, all patients received a single dose of parecoxib 40 mg and paracetamol 1g intravenously. Patients were assessed using visual analogue scale (VAS) for pain rating after extubation. During the postoperative period, all patients were prescribed with oral paracetamol 1g QID. Oral tramadol or oxycontin is the medication of choice for breakthrough pain. Pain scores were assessed at rest and cough at a regular interval of 2, 6, 12, 24, 48 and 96 hours postoperatively. If pain control is inadequate (pain score of >4), patient-controlled analgesia (intravenous morphine) was administered. All additional opioid usage during this postoperative period was documented.

For statistical analysis, we used IBM® SPSS® version 26 (Armonk, NY: IBM Corp.). Discrete variables were expressed as counts (percentage) and continuous variables as means ± standard deviation (SD). Frequency of groups were compared using Chi-Square or Fisher's Exact Test where applicable. Independent *t*-test and Mann-Whitney U Test was used for continuous data for normal and non-normal distributed continuous data. A *P* value of less than 0.05 was considered statistically significant.

Results

A total of 200 patients were recruited with 174 patients in the PPA arm and 26 patients with PCA. There is an equal distribution of gender and ethnicity in both groups. There were no significant differences in patients' weight and BMI. However, patients who received PPA were older age (63.29 vs 56.00, $P = 0.003$). A total of 118 patients in PPA cohort (67.8%) and 21 from PCA cohort (80.8%) underwent open surgery, with remaining underwent laparoscopic surgeries [Table 1].

Postoperative pain scores were consistently below 5 and reduced in trend from 2 hours to 96 hours postoperatively in both groups of analgesia [Figure 1]. There was no statistical difference in terms of the pain score at each interval between 2 groups [Table 2]. However, the PPA group revealed pain score on coughing at a lower trend than those with PCA alone [Figure 1]. Adding that the total dosage (mg) of opioid in PPA showed a significant reduction compared to PCA at the first 24 hours postoperatively 12.21 (±13.0) vs 20.0 (±14.43), $P = 0.048$ [Table 3].

Table 1: Demographics, ASA and surgery performed of the study population

n (%)	PPA *n*=174	PCA *n*=26	*P*
Mean Age, years (SD)	63.29	56.00	0.003*
Actual weight, kg (SD)	61.32	66.12	0.136*
BMI	23.51	24.93	0.193*
Gender			
Male	85 (48.9)	18 (69.2)	0.052**
Female	89 (51.1)	8 (30.8)	
Ethnicity			-
Chinese	93 (53.4)	9 (34.6)	
Indian	9 (5.2)	1 (3.8)	
Malay	71 (40.8)	13 (50.0)	
Others	1 (0.6)	3 (11.5)	
ASA			-
1	87 (50.0)	8 (30.8)	
2	83 (47.7)	15 (57.7)	
3	4 (2.3)	3 (11.5)	
Type of Surgery			
Open	118 (67.8)	21 (80.8)	-
Laparoscopic	56 (32.2)	5 (19.2)	

PPA, preperitoneal analgesia; PCA, patient-controlled analgesia; BMI, Body mass index, *independent t-test; **Chi-square

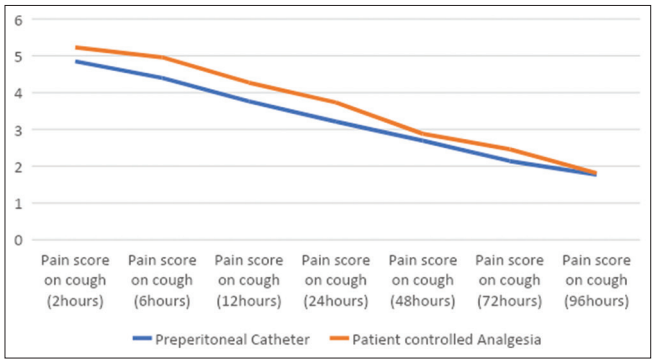

Figure 1: Pain score trend on coughing postoperatively with or without pre-peritoneal analgesia

Discussion

Literatures related to preperitoneal local anesthetic infusion for colorectal surgery has been reported since 2006.[4,5,7] During this period, there is a paradigm shift from open to laparoscopic surgery. Nevertheless, the usage of preperitoneal analgesia is still consistently being practiced in many regions where open surgeries is performed. Yet, it has not gained recognition on its efficacy for pain control following colorectal surgery. Recent Cochrane review identified that this was due to a lack of Asian literatures without any convincing data in regards to the use of this modality for pain control. However, we have started applying this mode of analgesia since 2017 in the majority of open colorectal elective surgeries. The initial reported experience in 64 patients revealed that the advantage of this modality were seen in the reduction of opioid use, hastening the post op recovery in terms of bowel movement and return to home.[3] The aforementioned study were of a single arm observational in nature; hence this current study was performed to take into consideration for comparative analysis of PPA and other modalities of pain relief.

In this current series, 20 to 30% of patients had laparoscopic assisted colorectal surgery in both arms. Nearly half of these patients had open rectal tumor resection and the remaining were colectomies. Compared to previous studies, the initial trials were performed in patients which underwent open midline laparotomy. With these benefits observed from

Table 2: Comparison of pain score post operatively between use of preperitoneal pump versus no preperitoneal infusion

Postoperative Hours	Mean Pain Score (SD)		*P**
	PPA	PCA	
2 H			
At rest	3.8 (2.096)	3.96 (1.865)	0.707
On cough	4.85 (2.21)	5.23 (1.966)	0.408
6 H			
At rest	3.42 (2.003)	3.73 (1.589)	0.450
On cough	4.40 (2.169)	4.96 (1.732)	0.208
12 H			
At rest	2.90 (1.851)	3.00 (1.470)	0.783
On cough	3.76 (2.095)	4.27 (1.801)	0.245
21 H			
At rest	2.38 (1.690)	2.23 (1.275)	0.669
On cough	3.21 (1.931)	3.73 (1.663)	0.196
48 H			
At rest	2.02 (1.548)	1.85 (1.047)	0.571
On cough	2.69 (1.793)	2.88 (1.681)	0.613
72 H			
At rest	1.68 (1.311)	1.58 (0.987)	0.696
On cough	2.14 (1.548)	2.46 (1.529)	0.334
96 H			
At rest	1.49 (1.138)	1.35 (0.846)	0.544
On cough	1.77 (1.348)	1.81 (1.059)	0.892

PPA, preperitoneal analgesia; PCA, patient-controlled analgesia; H, hours. *independent t-test

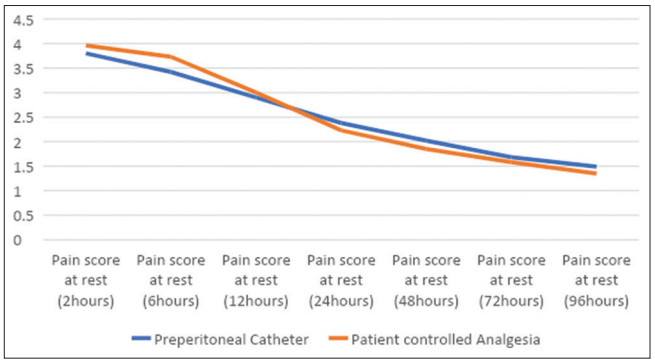

Figure 2: Pain score trend at rest postoperatively with or without pre-peritoneal analgesia

Table 3: Total dosing of opioid postoperatively between 2 arms

Postoperative Hours	Mean Pain Score (SD)		*P**
	PPA	PCA	
0 to 24 H	12.21 (13.001)	20.02 (14.734)	0.048
25 to 48H	10.51 (12.150)	16.40 (10.211)	0.147
49 to 72H	12.93 (17.308)	18.29 (10.996)	0.474
73 to 96H	27.50 (15.843)	10.00 (10.000)	0.158[a]
97 to 120H	32.00 (21.378)	10.00	0.467[a]

PPA, preperitoneal analgesia; PCA, patient-controlled analgesia; H, hours; [a]From 73H postoperatively, there were only 11 patients requiring patient-controlled analgesia. *independent *t*-test

open surgery, there were surgeons that decided to expand the usage of PPA into patients undergoing laparoscopic assisted colorectal surgery.[8] The combined analysis of open and laparoscopic surgery in the current series revealed comparable pain control to patient-controlled analgesia of opioids. Furthermore, there was a statistically significant decrease in the requirements of opioids in the early postoperative period (0 to 24 hours) [Table 3]. Sub-analysis was performed to compare PPA and PCA separately for either open [Supplementary Tables 1 and 3] or laparoscopic surgery cohorts [Supplementary Tables 2 and 4]. In the laparoscopic surgery cohort, it revealed that the addition of preperitoneal analgesia had a significant reduction in opioids requirement at first 24 hours post operatively compared to PPA alone [Supplementary Table 4]. These results were consistent with a previous study from the European group.

The pain score progression on cough for patients on preperitoneal analgesia revealed a lower pain score throughout the postoperative period [Figure 1]. These pain score comparison difference showed a higher gap at the initial 24 hours [Figure 1]. The pain score trend at rest did not reveal a difference between these two groups which may be due to usage of opioids and other oral rescue analgesia during the same period [Figure 2].

Although, the elastomeric pump used in this current study involved three different trademark companies, however the mechanism of action is the same. All three companies produced elastomeric pumps which were lightweight and portable. The catheters used were of the same material and it is easily removed by patients as there were no anchoring sutures. Current analysis includes the largest number of PPA used for elective colorectal surgeries in the country since its introduction to the local market. In addition, these surgeries were uniformly performed or supervised by a single colorectal consultant using the same surgical insertion technique. Though we included both open and laparoscopic surgery for the initial analysis, separate sub-group analysis revealed significant results of opioid requirement reduction only in the laparoscopic patient group. The limitations of this current study include small number comparison arm with PCA only, single center experience and non-randomized nature of study design. The reason of unequal allocation of both study groups was due to superior outcome on pain control and post op recovery following introduction of preperitoneal analgesia. Therefore, the subsequent cases were entirely supplemented with preperitoneal analgesia. We did not retrospectively search for more cases without preperitoneal analgesia as the local constraints of manual database limits our capability to trace back patients data accurately.

Conclusion

Preperitoneal analgesia is an effective additional analgesia to opioid analgesia after elective colorectal surgery. The reduction of pain is more evident on coughing or movement. It reduces the amount of opioid use postoperatively and is proven advantageous in laparoscopic colorectal surgery.

Declarations

Ethical Approval

This study is registered under the National Medical Research Register of Malaysia.

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Conflicts of interest

There are no conflicts of interest.

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Supplementary Table 1: Comparison of pain score post operatively between use of preperitoneal infusion versus no preperitoneal infusion. (Patient with Open Surgery Only)

	Preperitoneal Catheter Mean (SD)	Patient controlled Analgesia Mean (SD)	*P*
Pain score at rest (2 hours)	3.83 (2.135)	3.90 (1.786)	0.879
Pain score on cough (2 hours)	4.81 (2.153)	5.10 (1.786)	0.561
Pain score at rest (6 hours)	3.48 (2.016)	3.71 (1.586)	0.619
Pain score on cough (6 hours)	4.43 (2.171)	4.86 (1.769)	0.393
Pain score at rest (12 hours)	3.11 (1.990)	3.14 (1.526)	0.946
Pain score on cough (12 hours)	3.92 (2.182)	4.29 (1.875)	0.466
Pain score at rest (24 hours)	2.59 (1.811)	2.19 (1.327)	0.334
Pain score on cough (24 hours)	3.41 (2.039)	3.67 (1.826)	0.595
Pain score at rest (48 hours)	2.18 (1.677)	1.86 (1.108)	0.396
Pain score on cough (48 hours)	2.90 (1.908)	3.00 (1.761)	0.827
Pain score at rest (72 hours)	1.81 (1.379)	1.67 (1.065)	0.650
Pain score on cough (72 hours)	2.32 (1.649)	2.62 (1.627)	0.451
Pain score at rest (96 hours)	1.61 (1.168)	1.38 (0.921)	0.401
Pain score on cough (96 hours)	1.93 (1.413)	1.86 (1.108)	0.814

Supplementary Table 2: Comparison of pain score post operatively between use of preperitoneal pump versus no preperitoneal infusion. (Patient with Laparoscopic Resection Only)

	Preperitoneal Catheter Mean (SD)	Patient controlled Analgesia Mean (SD)	*P*
Pain score at rest (2 hours)	3.90 (2.055)	2.67 (0.577)	0.313
Pain score on cough (2 hours)	5.10 (2.271)	4.00 (1.000)	0.418
Pain score at rest (6 hours)	3.39 (1.820)	3.00 (0.000)	0.246
Pain score on cough (6 hours)	4.42 (1.911)	4.67 (1.155)	0.828
Pain score at rest (12 hours)	2.48 (1.546)	2.33 (0.577)	0.870
Pain score on cough (12 hours)	3.39 (1.667)	3.33 (0.577)	0.957
Pain score at rest (24 hours)	1.97 (1.538)	2.67 (1.155)	0.452
Pain score on cough (24 hours)	2.84 (1.791)	4.00 (1.000)	0.281
Pain score at rest (48 hours)	1.63 (1.418)	2.33 (0.577)	0.408
Pain score on cough (48 hours)	2.07 (1.530)	3.33 (0.577)	0.169
Pain score at rest (72 hours)	1.46 (1.414)	1.33 (0.577)	0.882
Pain score on cough (72 hours)	1.80 (1.472)	2.33 (0.577)	0.545
Pain score at rest (96 hours)	1.23 (1.412)	1.33 (0.577)	0.900
Pain score on cough (96 hours)	1.36 (1.432)	2.00 (1.000)	0.468

Supplementary Table 3: Total dosing of opioid postoperatively between 2 arms (open colorectal surgery only)

Postoperative Hours	Preperitoneal Catheter Mean (SD)	Patient controlled Analgesia Mean (SD)	*P*
0 to 24 H	14.13 (13.628)	19.50 (14.807)	0.229
25 to 48H	12.07 (12.781)	15.75 (10.306)	0.426
49 to 72H	15.00 (19.474)	18.29 (10.996)	0.697
73 to 96H	31.67 (16.503)	10.00 (10.000)	0.124[a]

[a]From 73H postoperatively, there were only 10 patients

Supplementary Table 4: Total Dosing of Opioid Postoperatively Between 2 Arms (Laparoscopy Surgery Only)

Postoperative Hours	Preperitoneal Catheter Mean (SD)	Patient controlled Analgesia Mean (SD)	*P*
0 to 24 H	3.00 (0.707)	27.00 (18.083)	0.041
25 to 48H	3.50 (0.707)	19.00 (11.533)	0.169
49 to 72H	9.50 (7.778)		
73 to 96H	15.00[a]		

[a]From 73H postoperatively, there were only 1 patient