

The Efficacy of Patient Controlled Analgesia for Acute Non Traumatic Abdominal Pain in Emergency Department

Kanesan K^a, NA Rahman NH^{b,c}

^aHospital Kuala Lumpur, Kuala Lumpur, Malaysia.

^bSchool of Medical Sciences, Health Campus, USM, Kota Bharu, Kelantan, Malaysia.

^cHospital USM, Health Campus, USM, Kota Bharu, Kelantan, Malaysia.

ABSTRACT

INTRODUCTION: Patient-Controlled Analgesia (PCA) is an intravenous self-administration of small doses of opioids (such as morphine) using a programmable pump. The goal of PCA is to efficiently reduce patients' pain at patient's preferred dose and schedule. Thus, we conducted a study to compare patient PCA morphine with intravenous bolus morphine for acute abdominal pain of non-traumatic origin in the emergency department (ED). **MATERIALS AND METHODS:** A randomised, non-blinded clinical trial was conducted in patients presented with severe acute non traumatic abdominal pain of less than 24 hours requiring opioid analgesic based on numerical pain score of more than seven at triage. The primary outcome was visual analogue pain score (VAS) recorded at 0, 30th, 60th and 120th minutes during the management in the ED and after admission to wards, and the secondary outcomes were total dosage of morphine used and degree of patient satisfaction. **RESULTS:** A total of 62 participants who fulfilled study criteria were randomized into PCA morphine group or bolus morphine group. The average amount of analgesic used for bolus morphine group was lower compared to PCA morphine (4.23 mg)(s.d 1.89 vs 5.29 mg)(s.d 2.16) ($p=0.027$). Despite of significant VAS score changes within group analysis, between group repeated measure ANOVA (RMA) VAS score analysis was not statistically significant. [Bolus group (6.7+2.03) compared to PCA group (5.83 + 2.38)]($p=0.089$). Patient satisfaction was statistically significant for the PCA group [PCA (1.65+0.709) compared to bolus group (2.23+0.920)]($p=0.007$). **CONCLUSIONS:** There was no significant difference in pain score reduction between PCA and intravenous bolus of morphine for the management of severe acute non traumatic abdominal pain in ED. However, PCA provided more patient satisfaction and should be considered as an alternative modality of acute pain management in ED.

Keywords

analgesics, acute pain, abdominal pain, patient controlled analgesia, opioids

Corresponding Author

Prof. Dr Nik Hisamuddin NA Rahman
Senior Consultant Emergency Medicine,
School of Medical Sciences,
Universiti Sains Malaysia,
16150 Kubang Kerian,
Kelantan, Malaysia
E-mail : nhliza@hotmail.com

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INTRODUCTION

Undertreating acute pain is a common occurrence in emergency room despite its frequent presenting complaint.^{1,2} Pain control in the ED for both trauma and non-trauma cases has been suboptimal according to many proven studies.^{3,4,5} Intravenous (IV) opioid use is a standard mode of practice for moderate to severe pain management. Intravenous opioids are commonly used route to provide analgesia as it acts faster and more efficient compared to other analgesics and routes of administration in a distress patient. In a routine practice, a physician will order a nurse to prepare and administer the opioids through the intravenous line. Commonly it is given in a titrating and escalating dose depending on patient's response.^{6,7} Additionally, titrating technique is applied to avoid patient developing adverse effect of opioid administration such as hypotension and respiratory depression. Technically in a busy ED, healthcare providers may delay the administration of analgesic due to attention being given to other cases resulting in patients' dissatisfaction in acute pain care.^{8,9} Hence alternative mode of administration which best suited patient care is by giving opioid through patient control analgesia (PCA). PCA is a mode of analgesic administration that deployson-demand, intermittent,

intravenous analgesic administration under patient control. It had been proven as an effective mode of pain relief in trauma related cases, often results in patient satisfaction and freedom when compared with other methods of analgesia administration. Most of PCA applications and studies were carried out in non ED setting such as in high dependency unit. Traditionally it is within the expertise of anaesthesiology and used for variety of conditions both acute and chronic pain.¹⁰ Based on literature search via MEDLINE, Google Scholar, Scopus and Web of Science, there is only a single published article more than a decade ago on the use of PCA morphine for all causes of acute abdominal pain attended ED.¹¹ Scarcity of evidence based application of PCA in ED among non-traumatic acute abdominal pain cases and suboptimal acute pain management in ED had been an impetus for the investigators to search for an alternative mode of acute pain management and to perform a randomized trial to compare the efficiency of PCA with intravenous (IV) boluses of morphine specifically for acute non accidental cause of abdominal pain. The rate of pain score change, total morphine dosage and patient satisfaction were also analysed.

MATERIAL & METHODS

A randomised trial was performed in ED of two tertiary centres. Randomisation was carried out using sample random assignment software. **(Figure 1)** The main inclusion criteria was all adult patients presented with severe non traumatic acute (less than 24 hours of onset) abdominal pain with VAS score at triage of more than seven.

Exclusion criteria include previous history of chronic pain of any cause, Glasgow Coma Scale of less than 15, hypotension (SBP \leq 90 mmHg), breathing rate \leq 10/min, coexistence of dementia or acute confusion states, visual impairment and blindness, history of allergy, inability to gain intravenous access, patients with history of diseases related to reduced pulmonary capacity; and prior treatment of acute pain of different modality.

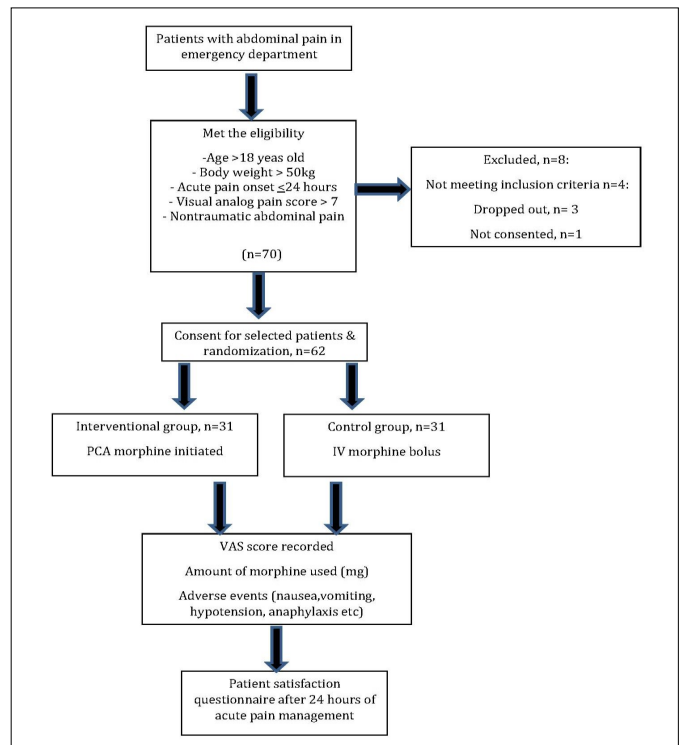


Figure 1: The CONSORT diagram of the study

Outcome Measures

The primary outcome for the study was VAS pain score reduction up to 2 hours during the management in the ED and after admission to wards. Secondary outcomes were total dosage of morphine used, occurrences of adverse events (allergies, respiratory depression, hypotension, vomiting) and patient satisfaction. Verbal consent was taken from patients who fit the inclusion criteria. Pain score of 7 or more is considered as severe pain according to guidelines by the British Association of Accident and Emergency Medicine (BAEM).^{12,13} The selected patients were randomised into 2 groups: intravenous (IV) bolus and PCA group. Maximum dose of morphine used for both groups were based on patients' body weight (0.1mg/kg). Control group received titration boluses of intravenous morphine sulphate at rate of 1-2 mg/min targeting for VAS score reduction or when the maximum dose has been achieved based on local guidelines and protocol of opioids administration (0.1mg/kg). The intervention group received analgesic via PCA pump prepared with syringe containing 50mg of morphine sulphate in 50ml normal saline with pre-programmed bolus dose of 1mg at a lock out interval of 5 min. Patients were instructed by nurses on how to use the PCA pump.

Observation parameters were carried out at 0, 30, 60, and 120 min for VAS score, vital sign and any adverse events. We used B Braun's Perfusion Space PCA Infusion Pump, model number 280744 manufactured in 2015. PCA preparation and instructions were carried out by trained medical officers and nurses who had initial training in PCA use carried out by expert in Acute Pain Service Unit. Total dose of morphine given and frequency of analgesia requested by the patient would be recorded for both groups. If patients were to ask for more analgesia and pain score has not reduced to satisfactory level, then they would be excluded from the study and a multimodal approach to pain relief would be used and referred to acute pain service team that is provided by the team from Anaesthesia Department for further care. The study intervention was carried out for maximum of two hours from the start of treatment initiated or till patients were admitted to wards. Finally, patients would be asked to complete questionnaire on pain management satisfaction either in wards or prior to disposal from ED. The questionnaire contains three short statement on satisfaction towards overall pain control, nursing care and doctor attitude toward pain management. Each of the stem is valued based on a 3 point likert scale (1=satisfied; 2=neutral; 3=not satisfied).

Statistics

Data was analysed by using SPSS program version 24 (SPSS Inc., Chicago, USA) that was licensed to the medical school. Descriptive, Independent t-test and repeated measure analysis of variance methods (Repeated measure ANOVA) were carried out. P value of less than 0.05 was taken as insignificant. Sample size of 60 (30 patients in each group) patients would give a confidence interval (CI) of 95% and a power of 80% to detect 20 millimetres (mm) change in VAS score between the two groups, after adjusting for non-adherence.

RESULTS

A total of 62 participants were included in the study with mean age of 41.2 (SD=11.9) in PCA group and 40.1 (SD=12.3) in bolus morphine group. Predominantly, 54.8% of them were male (n=34). Both groups did not

have any allergies or significant adverse events. **(Table 1)** No significant differences in the causes of pain for both groups. The causes of acute abdominal pain include acute appendicitis (n=17), intestinal obstruction (n=15), renal calculi (n=13), adhesion colic (n=9) and others (n=8). The average amount of analgesic used for bolus morphine group (4.23 mg)(s.d 1.89) was lower compared to PCA morphine (5.29 mg)(s.d 2.16) (p=0.027).

TABLE 1: Demographic comparison between the two study groups

Parameters	Groups		p value
	IV Bolus morphine	PCA morphine	
Total number (n)	31	31	
Age	40.1 (12.3)	41.2 (11.9)	0.65
Gender (n)	Male=17	Male=17	
Body weight (kg)	68.06(9.19)	68.51(8.35)	0.18
Initial VAS score	8.35(1.05)	8.13(0.991)	0.095
Acute appendicitis	10	7	0.655
Intestinal obstruction	6	9	0.071
Renal calculi	7	6	0.221
Others	7	10	0.075

PCA, patient controlled analgesia; VAS, Visual Analogue Score

The repeated measure ANOVA (RMA) within group analysis showed significant changes of VAS for each group over time however between group analysis of VAS score reduction was not significantly different. (Tables 2 & 3) VAS pain score reduction from 0 mins to 120 mins were faster in IV bolus group [6.7 (2.03)] compared to PCA group [5.83 (2.38), p=0.089]. (Figure 2)

TABLE 2: Comparison of Visual Analogue Score (VAS) within each treatment group based on time gap (Between group)

Within group VAS score Time Gap Measurement	PCA Morphine		Intravenous Bolus Morphine	
	MD (95% CI)	p-value	MD (95% CI)	p-value
0 – 30 minute	3.71 (2.64, 4.78)	<0.001	4.65 (3.35, 5.95)	<0.001
0 – 60 minute	4.38 (3.18, 5.60)	<0.001	5.58 (4.23, 6.93)	<0.001
0 – 120 minute	5.84 (4.80, 6.87)	<0.001	6.71 (5.50, 7.92)	<0.001
30 – 60 minute	0.68 (-0.32, 1.67)	0.38	0.94 (-0.01, 1.88)	0.53
30 – 120 minute	2.13 (0.88, 3.38)	<0.001	2.07 (1.19, 2.94)	<0.001
60 – 120 minute	1.45 (0.39, 2.51)	<0.001	1.13 (0.12, 2.14)	<0.001

Repeated measure Anova within group analysis was applied followed by pairwise comparison with 95% confidence interval adjustment by Bonferroni correction.

MD = mean difference

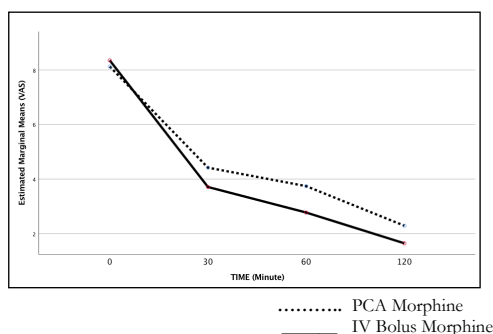


Figure 2: VAS change with time plot for the two treatment groups

Table 3: Comparison of Visual Analogue Scale between the two different treatment modalities based on time (Between group time-treatment interaction)

Time after Intervention	PCA/IV Bolus Morphine Group	Mean VAS	95% CI
0 minute	PCA	8.13	7.76, 8.49
	IV Bolus	8.36	7.99, 8.72
30 minute	PCA	4.42	3.69, 5.15
	IV Bolus	3.71	2.98, 4.44
60 minute	PCA	3.74	2.95, 4.53
	IV Bolus	2.77	1.98, 3.57
120 minute	PCA	2.29	1.67, 2.91
	IV Bolus	1.65	1.03, 2.26

Repeated measure ANOVA between group analysis with regard with time was applied. (All p values between group are more than 0.05)

Assumptions of normality, homogeneity of variances and compound symmetry were checked and were fulfilled.

Patient experience throughout acute pain management was not statistically different ($p=0.148$) however pain relief satisfaction was better for PCA [1.65(0.709)] compared to bolus group [2.23(0.920)] ($p=0.007$). (Table 4)

Table 4: Comparing the mean Likert scale scores for patient satisfaction

Variable	PCA Morphine (n=31)	IV Bolus Morphine (n=31)	Mean difference 95% confidence interval	T statistic	p value*
	**Mean(SD)	Mean(SD)			
Pain relief experience	2.19(0.873)	2.55 (1.028)	-0.355(-0.839-0.129)	-1.46	0.148
Satisfaction with pain relief	1.65(0.709)	2.23 (0.920)	-0.581(-0.998-(-0.163))	-2.782	0.007

*Independent samples t-test

**Likert scale scoring ranges from 1 to 3 (1= satisfied; 2=neutral; 3= not satisfied)

DISCUSSION

This study has proven that PCA morphine and IV bolus of morphine had comparable effects in reducing acute pain however patients felt more satisfied and comfortable with the use of PCA for their acute pain control. This clearly showed that patient satisfaction and scientific significant may contradict each other. The utmost crucial finding was the fact that both groups of intervention resulted in significant VAS measurement change over time.

Our study centre serves as a tertiary university hospital that receives approximately 90,000 patients annually. Majority (80%) is related to non-trauma and adults age group (85%) of population. Three percent of all adult

attendances present with abdominal related acute pain.^{14,15} Poor pain management is known to be associated with increased morbidity and mortality; thus optimal acute pain care is of utmost importance in promoting health recovery and adaptation.^{16,17} The optimal management of pain continues to be a challenge, with the prevalence of “oligo analgesia” or under treatment of pain being very high.¹⁸ The optimum strategy is to reduce patient’s pain, with minimal complications and yet maximum satisfaction in experience throughout the care, while allowing them to maintain function. The success of acute pain management can be attributed not only to the desirable pharmacological effects of analgesics, but also to the correct technique of analgesic administration that is personalized to the patient clinical characteristics. Strong opioids, such as morphine and fentanyl, are indicated at Step 3 of the analgesic ladder guideline produced by the WHO. Intravenous (IV) administration is generally preferred in critically ill patients specifically bolus IV injections of opioids with titration of subsequent doses may be used for control of moderate to severe pain.

In many settings, acute pain management is too clinician oriented and based mainly on the health care provider preference. Patients involvement in pain management decision is very limited and commonly neglected.¹⁹ Equally important is the practice of analgesic administration should be monitored regularly to ensure that pain resolves and analgesic requirements diminishes.^{20,21} Busy ED environment is a common limiting factor for nurses or doctors to perform well in acute pain management resulting in patient dissatisfaction. Nursing staff and doctors alike are commonly distracted with multiple different cases that present to the ED requiring simultaneous acute care resulting in delayed acute pain management.

On this basis, the investigator looked into an alternative method of opioid delivery for acute severe pain condition in the ED in particular among the non- traumatic abdominal pain cases. The rationale for choosing the specific group of non-traumatic cases was to ensure patient selection and interventional efforts minimized pathophysiological and anatomical variant of acute pain origin. One of acute pain management strategies to

enhance patient involvement in their pain control and hence satisfaction is via the use of PCA. PCA is a medication dispensing unit equipped with a pump attached to an intravenous line. Equipped with a simple push button mechanism, the patient can self-administer doses of pain relieving medication on an 'as need' basis. Generally, patients have their own control on the analgesic administration without having a need to call for nurses or doctors for the request. Scarce evidence relating to its use in the emergency setting exists despite many scientific evidences suggesting PCA use is more effective than standard methods of analgesia delivery in other clinical set up.²² Traditionally PCA is used mainly for perioperative pain management, obstetrics and trauma related conditions. More commonly it is used in general wards and intensive care units which is administered by anaesthetists or pain specialists.

Most of the previous studies looked into the comparison of PCA with IV boluses post operatively in a much controlled environment such as high dependency unit or general wards for surgical cases.^{23,24} Bijur et al has conducted a comparison study between PCA use and conventional care among 630 patients attended the ED of various causes and they have concluded that patient satisfaction for PCA use is better despite of several occurrences of adverse events and technical errors during the PCA administration.²⁵ Multicenter trial in the United Kingdom, Pain Solutions in Emergency Settings (PASTIEs), found almost similar finding in which adjusted analyses indicated non statistically significantly lower total pain experienced in the PCA group than in the standard care group. However this study only focused among traumatic cause of pain.²⁶ Rockett et al had carried out study in ED comparing effects of PCA use to usual treatment of pain among both traumatic and non-traumatic abdominal pain.²⁷ Their study had shown the abdominal pain group, 13 out of 50 (26%) patients using PCA developed persistent pain vs. 11 out of 27 (41%) of those with usual treatment. Whereas for traumatic pain, 25 out of 35 (71%) patients given patient-controlled analgesia developed persistent pain vs. 20 out of 29 (69%) patients with usual treatment. The above two studies clearly indicated that PCA method of acute pain management in ED has some differences in its effects on

patients if compared to usual treatment especially in the non-traumatic abdominal pain cases.

More importantly, patient satisfaction in acute pain management should be a crucial performance indicator of patient care. Interestingly, the PCA group scored higher degree of satisfaction despite of less pain score reduction when compared to the bolus group. This finding is supported by PASTIEs study in which the investigators found patients received PCA reported more satisfaction compared with the treatment as standard care group [86% (78/91) *v* 76% (74/98)].^{29,30} Perceived control such as avoidance of delay in receiving analgesic and not having to call on the nurses for more medications have been shown to have significant association with higher satisfaction rating.

Strength and Limitation of the Study

This study focussed only on acute abdominal pain of non-traumatic origin in hoping to limit the contribution of multiple different pathologies that might have skewed the pain score and hence satisfaction level. All of studies in the past focussing on both traumatic and non-traumatic causes of pain. Other studies compared PCA group with other general modality of analgesic administration, whereas our study focussed comparison only with intravenous bolus group.

Multimodal analgesic therapy received by patients was the major contribution towards excluding the sample from the study hence limiting bigger sample analysis. Non-blinding of patient recruitment was another weakness and this may have caused Hawthorne's effect of trial. Blinding of patients and staff were not practical as this would have interfered with standard management and might compromise patient safety. Recommendation for future research would be to study on the health economics impact such as cost-benefit, cost-effectiveness, cost-minimization between PCA and bolus group and the use of other drug such as Fentanyl. The robust scientific findings on the efficacy and safety of PCA use in critical care and ED setting had opened up opportunity for clinicians to translate the research work into real clinical practice.

CONCLUSION

Both interventions provided significant pain score reduction. However there was no significant difference in pain score reduction between PCA morphine and IV bolus of morphine for the management of severe acute non-traumatic abdominal pain in ED. PCA morphine provided more patient satisfaction and should be considered as an alternative modality of acute pain management in ED.

FUTURE PERSPECTIVE

The role of emergency health care providers in treating acute pain is crucial to avoid progression to chronic state resulting in an increase comorbidity and reduction in quality of life. Patient involvement rather than clinician centred in acute pain management significantly improves patient satisfaction and hence reduces traumatic experience during the visit to emergency department. Use of PCA will certainly provide a much more pleasant experience for patients in critical setting. Hence PCA use should be a common and standard practice beyond the ICU or wards setting, extending to pre hospital and emergency department care. Equally important, acute pain management in emergency department should involve collaborative effort with acute pain experts to ensure early and optimum care given to patients.

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FUNDING

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DATA AVAILABILITY

Data is kept in a secured electronic file by both the authors KK & NHNAR. Data will be kept for 7 years post study

completion at which it will be permanently deleted

CONFLICT OF INTEREST

Non presence throughout the conduct of the study

Informed consent:

Informed consent via manual form was carried out and checked and approved by study centre ethical committee

ETHICAL APPROVAL AND HUMAN RIGHT

This study has obtained ethical approval from ethics and research committee of the Universiti Sains Malaysia. The conduct of the study followed the requirements of the ethical and protection of human rights recommended by the board and WMA Declaration of Helsinki.

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