Local and Regional Anesthesia

Dovepress
Taylor & Francis Group

Open Access Full Text Article

CLINICAL TRIAL REPORT

Could Wound Instillation Provide an Efficient Analgesia Comparable to That Provided by PECS-II Block for Modified Radical Mastectomy Using Ketamine–Bupivacaine Combination? A Pilot Study

Ahmad M Abd El-Rahman[1], Saif Eldeen Gamal Khalaf[1], Mohamed H Bakri[2]

[1]Department of Anaesthesia, Pain, and ICU, South Egypt Cancer Institute, Assiut University, Assiut, Egypt; [2]Department of Anaesthesia, Pain, and ICU, Faculty of Medicine, Assiut University, Assiut, Egypt

Correspondence: Ahmad M Abd El-Rahman, Department of Anaesthesia, Pain, and ICU, South Egypt Cancer Institute, Assiut University, Assiut, Egypt. South Egypt Cancer Institute, Assiut University, El-Mithaq Street, Mansheit Al Omara, Assiut City, Assiut, Egypt, Tel +20114960606O, Fax +20882348609, Email ahmad23679@gmail.com

Local and Regional Anesthesia downloaded from https://www.dovepress.com/
For personal use only.

Background and Aim: In the light of the abundance of various analgesic methods available for analgesia following modified radical mastectomy (MRM) (pharmacological or interventional), we aimed to try a very simple technique using a drug combination (ketamine–bupivacaine) through wound instillation and to compare it to the reputable PECS-II block using the same drug combination. We hypothesized that, with this drug combination, local instillation may achieve a comparable, long lasting, analgesia for almost 48 hours, with less costly, and simple method.

Patients and Methods: Sixty women scheduled to undergo MRM participated in this study. Patients were randomized to have either; ultrasound-guided, modified PECS block (PECS group), or instillation of analgesics into the surgical wound (local instillation group). In both groups, we used 1 mg/kg ketamine HCL plus 0.25% bupivacaine HCL in a 30 mL volume. Total consumption of rescue morphine, time to 1st analgesic request, numerical rating scale (NRS), hemodynamic effects were recorded over 48 hours postoperatively. In addition, the time required to perform either technique and possible side effects were recorded.

Results: Total consumption of rescue morphine, first analgesic request, pain scores, showed no statistically significant differences in both groups; the local instillation procedure required a statistically significant shorter time to perform than the PECS procedure. None of the groups showed significant differences in the incidence of adverse effects.

Conclusion: Local wound instillation provided a comparable analgesia to PECS-II block following modified radical mastectomy. Ketamine–bupivacaine combination prolonged analgesia for almost 2 days.

Keywords: PECS block, wound instillation, ketamine, bupivacaine, modified radical mastectomy

Introduction

Pain after modified radical mastectomy (MRM) may have a significant impact on the quality of life as it may interfere with, and seriously affect a patient's psychological condition.[1]

Opioids, the corner stone in postoperative pain relief, can result in significant postoperative untoward effects. These include sedation, nausea, vomiting, urinary retention, respiratory depression, and postoperative ileus.[2]

PECS-II block (or "modified PECS blook" according to *Blanco et al*[3]) includes laying local anaesthetic between pectoralis muscles (major and minor, as in PECS-I) and furtherly between pectoralis minor and the serratus muscle, aims to open the "axillary door", blocking of the serratus region, and lateral branches of the intercostal nerves that exit at the level of the mid-axillary line from T2 to T6. According to them, Pecs II block is an easy alternative that produces excellent analgesia compared to other, more complex, blocks used for postoperative analgesia in breast surgery.[3]

Received: 6 February 2025
Accepted: 22 July 2025
Published: 18 August 2025

© 2025 Abd El-Rahman et al. This work is published and licensed by Dove Medical Press Limited. The full terms of this license are available at https://www.dovepress.com/terms.php and incorporate the Creative Commons Attribution – Non Commercial (unported, v4.0) License (http://creativecommons.org/licenses/by-nc/4.0/). By accessing the work you hereby accept the Terms. Non-commercial uses of the work are permitted without any further permission from Dove Medical Press Limited, provided the work is properly attributed. For permission for commercial use of this work, please see paragraphs 4.2 and 5 of our Terms (https://www.dovepress.com/terms.php).

New analgesics and combinations of existing ones are being used to optimize postoperative pain management. Ketamine, a well-known anesthetic medication that primarily acts as a noncompetitive antagonist of the N-methyl-D-aspartic acid receptors (NMDA), however, it seems to possess a more complex central and peripheral mechanisms of action including; interaction with several receptors such as opioid and γ-aminobutyric acid (GABA) receptors and others, it also inhibits CNS sensitization which reduces allodynia and hyperalgesia, its metabolites also seem to play a role its analgesic effects.[4] It has been used successfully (in low, sub-anesthetic, doses) for postoperative pain management. It showed an opioid-sparing effect, and thus, it reduces opioid-related side effects.[5] Hence, its addition to local anesthetics is expected to improve analgesia and prolong its duration.

In this study, we compared PECS-II block that has an excellent reputation in postoperative analgesia following MRM to local wound instillation which seems, despite being simple, to be effective. We hypothesized that; local wound instillation could provide an analgesia that is comparable to that offered by PECS-II block following MRM, this could be valuable where equipment and trained hands for plane blocks are not available. We used a combination of ketamine and bupivacaine to provide a longer period of analgesia.

Patients and Methods

Study Setting & Design

This randomized, single-blinded study was approved by the Institutional Review Board of the South Egypt Cancer Institute and Ethics Committee of the Faculty of Medicine, Assiut University, Assiut, Egypt, and it was conducted in agreement with the Declaration of Helsinki. Written informed consents were obtained from all the participating patients. The study was registered at www.clinicaltrials.gov (Number: NCT 05410158) before enrollment of the first patient.

Selection Criteria

All female patients aged 18–65 years, with a confirmed diagnosis of breast cancer, scheduled for modified radical mastectomy with a body mass index (BMI) between 18 and 30 kg/m^2 were eligible for recruitment.

Patients with one or more of the following criteria were excluded: significant cardiac, respiratory, renal, or hepatic disease; alcohol abuse; psychiatric or mental illness that would affect the perception and assessment of pain, history of bleeding tendency of any cause, addiction, infection (at or near the site of the planned block), previous surgery in the supraclavicular, infraclavicular, or axillary regions.

Sixty patients were included and randomized into two equal groups: the pectoralis nerve block (PECS) group (n = 30 patients) and the topical instillation group (n = 30 patients). A flowchart of the cases through the study is presented in Figure 1.

Methodology

Preoperatively, patients were given a tutorial on how to evaluate their own pain intensity using, a 0 to 10, "Numerical Rating Scale" (NRS); (where 0 = no pain and 10 = worst pain imaginable). All patients were given oral midazolam 5 mg as a premedication at the night previous to surgery.

At OR time, an intravenous line was already there in the upper limb contralateral to the side of the surgery. Standard ASA monitoring probes were applied including electrocardiography (ECG), noninvasive blood pressure (NIBP), arterial oxygen saturation (SaO_2), and end-tidal carbon dioxide ($EtCO_2$).

All patients received general anaesthesia following the same protocol to provide a balanced anaesthesia without the use of any moderate, or long, -acting analgesics that could affect our results. Induction was accomplished using fentanyl 2 µgm/kg, lidocaine 1mg/kg, propofol 2 mg/kg, endotracheal intubation was facilitated by rocuronium 0.6 mg/kg. Maintenance of anaesthesia was done using sevoflurane inhalation in a mixture of oxygen and air. Mechanical ventilation was provided using settings to maintain an $EtCo_2$ of 35–45 mmHg. At the end, reversal of muscle relaxation was done using sugammadex 2 mg/kg. Intraoperative euvolemia and normothermia were maintained.

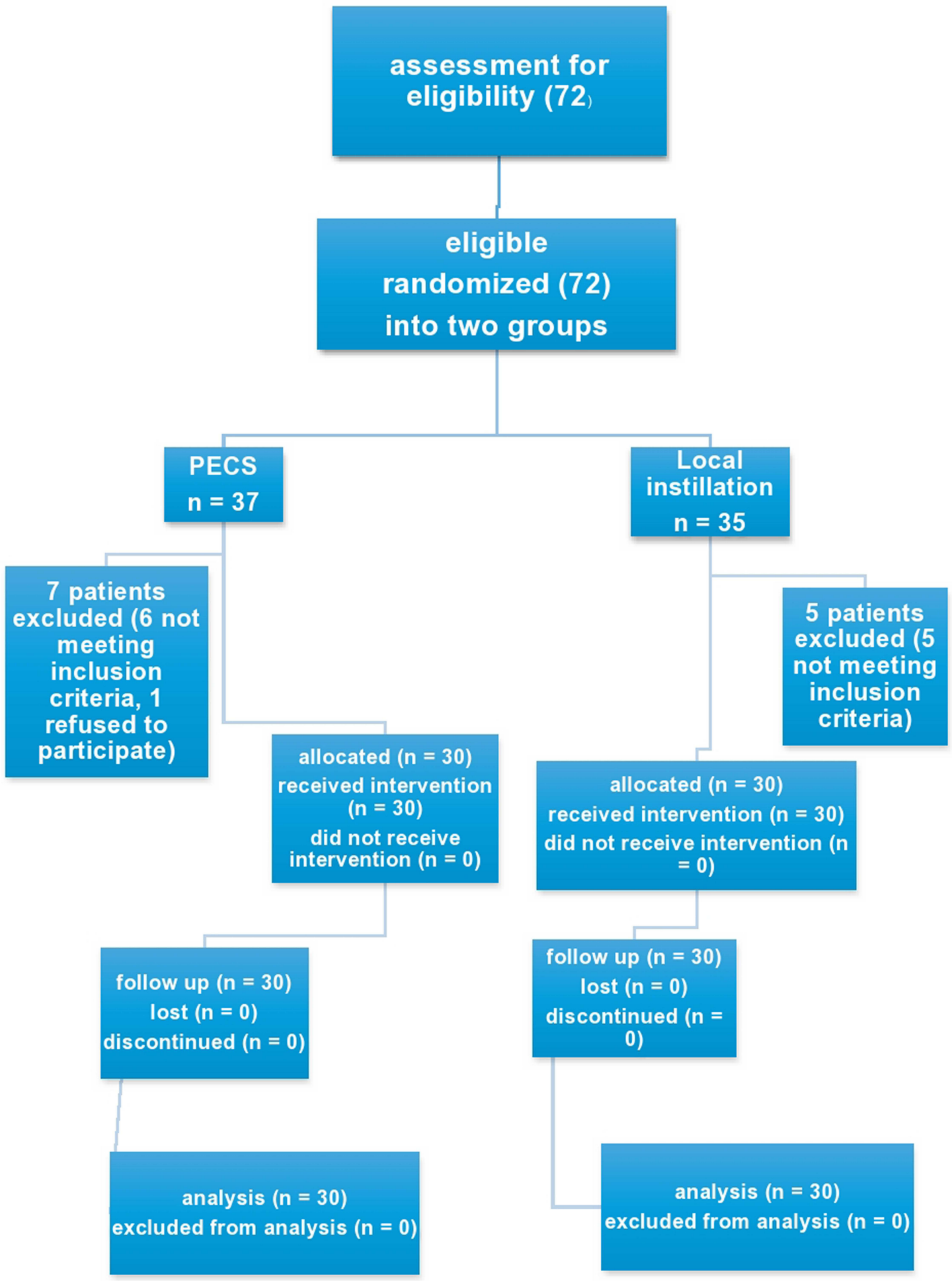

Figure 1 Flow chart of the current study.
Abbreviation: PECS, pectoralis nerve block.

PECS Block Group (PBG)

Patients were administered a total volume of 30 mL of 0.25% bupivacaine hydrochloride (Markyrene® Sigma Tec, Egypt) and ketamine hydrochloride (1 mg/kg) (Ketamine® Sigma-Tec, Egypt). The PECS-II block was performed after induction of general anesthesia and before skin incision, while the patient was in the supine position with the ipsilateral upper limb abducted 90° after local site preparation and draping, using an 80 mm 21 G needle (Pajunk® SonoPlex Stim cannula U.S.A) with a high-frequency linear array ultrasound probe (Sonosite®, Inc. U.S.A)., starting from the outer third of the clavicle as in PECS-I and moving caudally and outwards to the midaxillary line, then pectoralis minor and serratus anterior were identified by moving laterally. While moving the probe laterally, the second rib, just under the axillary artery, and the third rib are both identified, then moving furtherly lateral shows the fourth rib, where injection of local

https://doi.org/10.2147/LRA.S515752

anesthetic between pectoralis major and minor (10 mL) and then a little deeper between pectoralis minor and serratus anterior muscles (20 mL) was done. Skin incision was performed after surgical site preparation and draping, allowing a period of 15 minutes after the block was performed.

Topical Instillation Group (TIG)

After breast excision and subsequent surgical hemostasis were accomplished, patients received 1 mg/kg ketamine hydrochloride in 30 mL of 0.25% bupivacaine hydrochloride, which was already prepared in a sterile syringe and irrigated, evenly, into the surgical bed just before wound closure. To allow maximum contact between the study medications and the tissues, the suction drains were kept closed for 30 minutes after the end of surgery.

Follow up

All patients were evaluated at baseline, one, 2, 4, 6, 12, 24, 36, and 48 hours postoperatively for vital signs (heart rate, non-invasive arterial blood pressure, respiratory rate, and oxygen saturation) and NRS scores. Upon evaluation of postoperative pain, and whenever NRS was 3 or more, rescue analgesia was given in the form of intravenous morphine bolus slow injection of 0.05 mg/kg). The time to the first request for rescue analgesia and total morphine consumption within 48 hours were recorded.

In addition, possible side effects were recorded and managed accordingly, this included; the incidence of sedation, chest pain, nausea, vomiting, respiratory depression, pruritus, psychological complications (hallucination, delirium, dreams, nystagmus, dissociative effects), and traumatic injuries (including development of hematoma) at the local block site.

Outcome Measures

- Our primary outcome measure was the total dose of morphine consumed during the first 48 hours postoperatively.
- Secondary outcome measures were postoperative NRS score, time to first request for rescue analgesics, number of rescue analgesic doses, and possible untoward effects.

Sample Size Calculation

No previous studies have compared the analgesic efficacy of local anesthetics in pectoralis plane block versus local instillation into the surgical wound; however, based on other studies that investigated the effect of using local anesthetics in peripheral nerve blocks and other studies using local anesthetic instillation for postoperative analgesia with an expected background standard deviation of 1.0, an alpha error not exceeding 0.05 and a power of 80%, we estimated that 28 patients in each group would be required. To compensate for dropouts, 30 patients were recruited from each group to account for random errors and additional comparisons.

Statistical Analysis

Data were collected and analyzed using SPSS® (Statistical Package for the Social Sciences, version 20, IBM, Armonk, New, USA). The Shapiro test was used to determine compliance of the data to a normal distribution. Quantitative data are expressed as mean ± standard deviation (SD) and compared using Student's *t*-test. Nominal data are presented as number (n) and percentage (%). Chi^2 test was performed for these data. The level of confidence was maintained at 95%; hence, *P* P-value < 0.05, was considered significant.

Results

Both groups showed no significant differences in baseline data (Table 1). However, the duration of local instillation was significantly shorter (Figure 2) (12 ± 2.92 vs 1.70 ± 0.54 (minute); $p< 0.001$) in PECS group and topical instillation group, respectively.

Both groups showed insignificant differences in the post-operative assessment of hemodynamics. There was also no difference in NRS scores between the groups (Figure 3, Table 2) ($p> 0.05$).

Table 1 Baseline Data and Operative Time of the Studied Groups

	PECS Group (n= 30)	Topical Instillation Group (n= 30)	*P* value
Age (years)	51.13 ± 9.54	50.33 ± 7.84	0.45
BMI (kg/m^2)	26.19 ± 3.03	26.23 ± 1.78	0.95
ASA class			0.60
Class-I	18 (60%)	19 (63.3%)	
Class-II	12 (40%)	11 (37.7%)	
Affected side			0.50
Right	15 (50%)	14 (46.7%)	
Left	15 (50%)	16 (53.3%)	
Duration of technique (minute)	12 ± 2.92	1.70 ± 0.54	**< 0.001***

Notes: Data expressed as mean (SD), frequency (percentage). *P* value was significant (*) if < 0.05.
Abbreviations: PECS, pectoralis plane block; ASA, American Society of Anesthesiologists; BMI, body mass index.

There was no significant difference between the two studied groups as regard the time to first request of rescue analgesic (14.4 ± 15.24 vs 13.2 ± 14.22 hours; $p = 0.75$) in PECS group and topical instillation group, respectively, and the total morphine consumption (2.43 ± 2.57 vs 2.37 ± 2.58 mg; $p = 0.92$) in PECS group and topical instillation group, respectively (Table 3).

Reported Side Effects in the Studied Groups

Both groups had insignificant differences with regard to the overall frequency of side effects, with the majority (63.3% in the PECS group and 70% in the topical instillation group) of both groups reporting no side effects. Eleven (36.7%) and seven (23.3%) patients suffered from vomiting in the PECS and topical instillation groups, respectively. Sedation was reported in only two patients who underwent topical instillation.

Discussion

The main findings of the current study included; both techniques had similar total dose of morphine consumption, pain score values (NRS), time to first request of rescue analgesic, with only minimal quantitative differences between the two

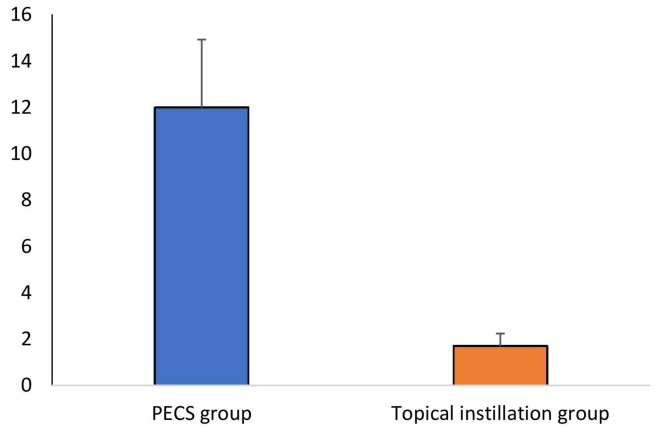

Figure 2 Mean time of each procedure in the current study.
Abbreviations: PECS, Pectoralis plane block.

https://doi.org/10.2147/LRA.S515752

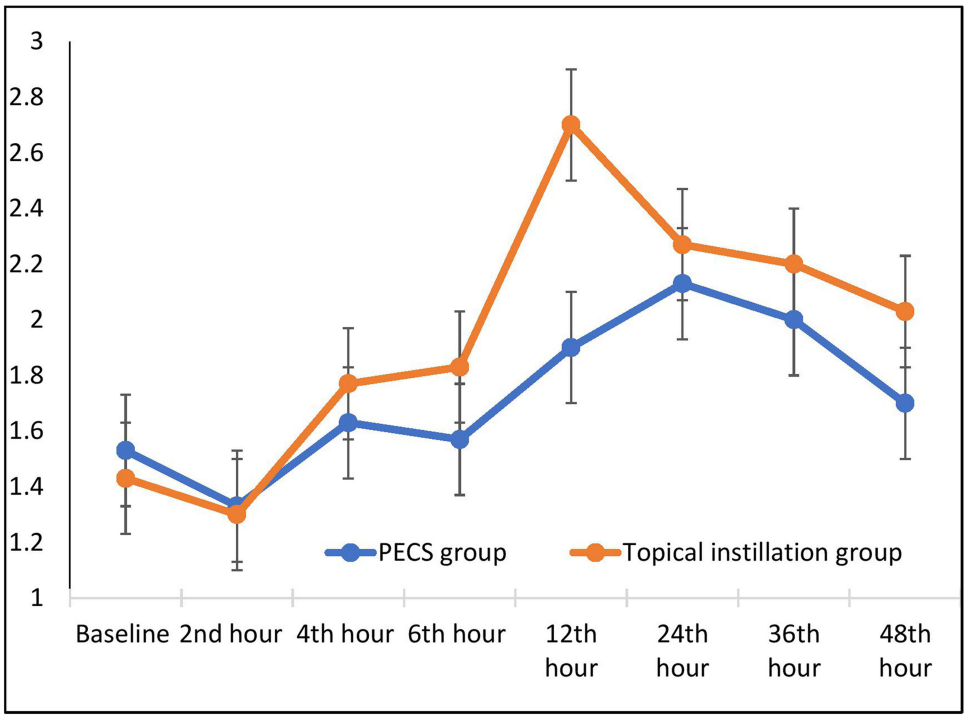

Figure 3 Postoperative numeric rating scale in the studied groups.
Abbreviations: PECS, Pectoralis plane block.

groups that was of no clinical significance. Local instillation procedure required significantly shorter time to be performed in comparison to PECS block.

Various techniques have been used to alleviate postoperative pain after MRM.[6] However, these techniques are arduous and technically demanding; they require costly equipment (imaging devices, needles, and catheters) that are not available everywhere, and they require time for training to achieve better performance including higher success and lower complication rates.

Speaking about the available simple postoperative analgesic techniques that were found to be useful for postoperative analgesia for several types of surgery is the wound infiltration (WI) with local anesthetics. However, WI, whether done through single injection or continuous wound infiltration (CWI), requires additional time at the end of surgery to be

Table 2 Post-Operative Assessment of NRS Among the Studied Groups

NRS	PECS Group (n=30)	Topical Instillation group (n=30)	P value
Baseline	1.53 ± 0.95	1.43 ± 1.00	0.44
2nd hour	1.33 ± 0.90	1.30 ± 0.92	0.78
4th hour	1.63 ± 0.95	1.77 ± 0.97	0.49
6th hour	1.57 ± 0.94	1.83 ± 0.91	0.32
12th hour	1.90 ± 0.92	2.10 ± 0.96	0.08
24th hour	2.13 ± 0.91	2.27 ± 0.98	0.77
36th hour	2.00 ± 0.90	2.00 ± 0.95	0.66
48th hour	1.70 ± 0.94	2.03 ± 0.92	0.24

Table 3 Time to 1st Analgesia Request and Morphine Consumption in Both Groups

	PECS Group (n= 30)	Topical Instillation Group (n= 30)	*P* value
Time to first analgesic request (hour)	14.4 ± 15.24	13.2 ± 14.22	0.75
Morphine consumption (mg)	2.43 ± 2.57	2.37 ± 2.58	0.92

Note: Data expressed as mean ± (SD). *P* value was significant (*) if < 0.05.
Abbreviation: PECS, pectoralis plane block.

accomplished and CWI involves placement of special catheters, which are costly. Furthermore, it still possess the potential of untoward effects including; wound infection, hematoma formation, catheter leakage, kinking or occlusion, with failure to infuse, and unintentional removal.[7]

The present study showed that topical instillation was comparable to the PECS block regarding postoperative pain control, as evidenced by the total morphine consumption and the duration of postoperative analgesia that was monitored by NRS values for 48 hours.

Shamim and Perveen concluded that instillation of bupivacaine via surgical drains into MRM (with axillary lymph node dissection) wound offered a good analgesia and had a painkiller – sparing effect. With subsequent rapid recovery and better overall performance. Yet, they did not explore the effect of adding adjuvants to local anesthetics.[8]

Jonnavithula and others have found that local anesthetic application into post-mastectomy wound is an efficacious, simple method of postoperative analgesia that has been studied frequently in the last few years.[9] This was agreed with by Chhatrapati and his colleagues who found that wound instillation, is a noninvasive effective method providing post-operative analgesia following MRM in comparison to other available, more-invasive, modalities.[10]

Ketamine is an anesthetic drug that is of valuable criteria regarding postoperative analgesia. Confirming the potential local effects of ketamine, is the fact that N-methyl-D-Aspartate Receptors (NMDA), which are considered the primary site of action of ketamine, were found to be present on peripheral primary afferent neurons in the hairy skin of humans.[11]

Peripheral mechanisms of action of ketamine include binding to several types of receptors including; opioid receptors, muscarinic and nicotinic cholinergic receptors, D2 and 5-HT2 receptors, it acts by inhibiting receptor ion channels (Na^+, Ca^{+2}, K^+). It has some peripheral cellular effects including decreased activation and migration of microglia and inhibition of production of inflammatory mediators.[12]

We hypothesized, in this study, that comparing these two techniques of postoperative analgesia in patients undergoing mastectomy would be interesting, as both are tried before (solely) with successful results. Thus, there is a great chance of successful postoperative analgesia, but the following questions are still to be answered; could this analgesia last – with the use of ketamine as an adjuvant – for 48 hours with an opioid sparing effect? And if both techniques are comparably effective, then why we do not use the more simple, less invasive "instillation" technique with lower cost?

El Sherif and others[13] investigated the analgesia offered by ketamine instillation in three different doses of 1, 2, and 3 mg/kg on both acute and chronic postmastectomy pain for 48 hours and for 6 months, respectively. The three doses were effective and satisfactory to patients with minimal side effects. Moreover, patients who received 3 mg/kg ketamine showed the best results with the lowest VAS and no need for PCA rescue morphine during the study, and they did not develop chronic pain during the six-month period of follow-up.

Moharari and colleagues[14] concluded that lidocaine gel mixed with ketamine applied into the urethra alleviated pain during outpatient rigid cystoscopy. Nejat and his colleauges[15] also found that when ketamine was added to local intranasal lubricating gel, it markedly improved nasogastric tube insertion pain.

In contrast, a study by Fredman et al[16] found that repeated wound instillation of 0.25% bupivacaine solution following major abdominal surgery, did not decrease postoperative pain or opioid consumption. The authors explained that by the possible lack of even distribution and spread of the drug, and by the possible insufficient dose of the local anesthetic.

Talbot[17] who irrigated local anesthetics into the axillary drains, following a modified radical mastectomy found that it did not improve much postoperative analgesia in some patients. They referred that to possibly mis-positioned drains, or

to possible blockade of some drains holes with lack of uniform distribution of the local anesthetic solution, and recommended further refinement of that technique in the future studies.

The differences observed in the duration of analgesia even after administration of standardized weight-based dosages with the same volume and concentration of local anesthetic can be attributed to the variation in the anatomical structure of the deep fascia and the pathway of nerves through the fascial layers.[18] Our results regarding the time to first request for rescue analgesia for both techniques, were comparable to data from previous studies.[19–21]

Many studies have demonstrated the efficacy of local ketamine infiltration for acute pain management. For example; Mohamed et al[22] concluded that surgical wound infiltration with ketamine at a dose of 2 mg/kg added to bupivacaine reduced the total opioid consumption, delayed the first request of rescue analgesic, and blunted the postoperative stress response. Furthermore, Javid et al[23] compared subcutaneous to intravenous ketamine when both were added to narcotic agents, and they found that subcutaneous ketamine was of comparable efficacy to intravenous ketamine, yet it was more safe as it avoided the systemic untoward effects.

Also, Othman et al,[24] who followed his patients for 48 hours, found that adding 1 mg/kg of ketamine to the local anaesthetic in a modified pectoral block, was associated with increased time to the first request of rescue analgesic and it had an opioid sparing effect.

Using ketamine, whether injected into the fascial planes, or instilled directly into the open wound most probably bypasses systemic absorption and consequently minimizes the side effects observed when using IV or IM forms of ketamine. Honarmand et al[25] revealed no significant hypotension or bradycardia associated with local ketamine in comparison to other systemic forms. Furtherly, El Sherif et al,[13] found no ketamine- related side effects in their study that included using ketamine in different doses up to 3 mg/kg.

The absence of ketamine well-known side effects (confusion, dizziness, dissociation, hallucinations, nystagmus, chest pain) in our patients is in agreement with the results reported by other studies,[26,27] which could be referred to the use of low dose of ketamine and possible slow release of it into the systemic circulation.

In fact, the side effect profile of our patients was favorable, as it only included the occurrence of vomiting in some cases in both groups, this could be attributed to many reasons that are common in both groups of the study, all of our patients are females, and being a female is a risk factor for postoperative nausea and vomiting. Moreover, postoperative nausea and vomiting was reported as one of the most common complications postoperatively, with higher incidence in women undergoing cancer surgery, as most of these patients are exposed, at some time in their course of treatment, to chemotherapy.[28–30] Following mastectomy, it was reported that the incidence of PONV is as high as 80%.[31–33] The use of ketamine may be responsible, at least in-part, for some of these cases as nausea and vomiting are among its side effects.

We can say that our results are in concordance with almost all of the results regarding the beneficial analgesic effect of both PECS block or local wound instillation with the addition of ketamine in both groups. However, and up to our knowledge, it is the first time to compare analgesia from both techniques (PECS block and local instillation) to each other. This may sound "silly" to some (comparing an ultrasound-guided plane block to a simple wound "instillation"), however, we think that achieving the main goal, that in our case is; postoperative analgesia, with the simplest, easiest, least costly and least invasive technique is a universal target for all practicing physicians in their respective fields.

We are not recommending here to abandon the use of ultrasound – guided PECS block, it is a successful and safe technique that has been practiced for years with great results, we are just advising that when the needed equipment are not available, or when trained physicians on such a block are lacking in a health facility that used to have that kind of surgeries, then the "local-wound instillation" method should be considered as an efficacious alternative.

There is a number of limitations in the current study, these include; the relatively small sample size, the lack of a control group, the lack of assessment of intraoperative haemodynamics (which could reflect better analgesia in the PECS-II group taking into consideration the timing of the block that was pre-emptive) and the lack of assessment of the risk of chronic pain development. We recommend these points to be considered and avoided, as possible, if further research in this respect is to be performed.

Conclusion

Local wound instillation had an analgesic efficacy that is comparable to that of modified PECS block using ketamine–bupivacaine combination following MRM. Local instillation had the advantages of being simple, less time-consuming, less invasive, and less costly.

Data Sharing Statement

The authors confirm that the data supporting the findings of this study are available within the article.

Ethics Approval and Informed Consent

This study is approved by the institutional review board of South Egypt Cancer Institute, Assuit University, Assuit City, Egypt. And it was registered at www.clinicaltrials.gov (Number: NCT 05410158)

Disclosure

The authors report no conflicts of interest in this work.

References

1. Miguel R, Kuhn AM, Shons AR, et al. The effect of sentinel node selective axillary lymphadenectomy on the incidence of postmastectomy pain syndrome. *Cancer Control*. 2001;8(5):427–430. doi:10.1177/107327480100800506
2. Richebé P, Beaulieu P. Perioperative pain management in the patient treated with opioids: continuing professional development. *Can J Anaesth*. 2009;56(12):969–981. doi:10.1007/s12630-009-9202-y
3. Blanco R, Fajardo M, Maldonado TP. Ultrasound description of Pecs II (modified Pecs I): a novel approach to breast surgery. *Rev Esp Anestesiol Reanim*. 2012;59(9):470–475. doi:10.1016/j.redar.2012.07.003
4. Ma X, Yan J, Jiang H. Application of ketamine in pain management and the underlying mechanism. *Pain Res Manag*. 2023;2023:1928969. doi:10.1155/2023/1928969
5. Dong C, Anand K. Developmental neurotoxicity of ketamine in pediatric clinical use. *Toxicol Lett*. 2013;220(1):53–60. doi:10.1016/j.toxlet.2013.03.030
6. Katz J, Poleshuck EL, Andrus CH, et al. Risk factors for acute pain and its persistence following breast cancer surgery. *Pain*. 2005;119(1–3):16–25. doi:10.1016/j.pain.2005.09.008
7. Stamenkovic DM, Bezmarevic M, Bojic S, et al. Updates on wound infiltration use for postoperative pain management: a narrative review. *J Clin Med*. 2021;10(20):4659. doi:10.3390/jcm10204659
8. Shamim SU, Perveen S, Ahmed T, et al. Postoperative analgesia in modified radical mastectomy patients after instillation of bupivacaine through surgical drains. *Cureus*. 2022;14(4):e24125. doi:10.7759/cureus.24125
9. Jonnavithula N, Khandelia H, Durga P, Ramachandran G. Role of wound instillation with bupivacaine through surgical drains for postoperative analgesia in modified radical mastectomy. *Indian J Anaesth*. 2015;59(1):15–20. doi:10.4103/0019-5049.149443
10. Chhatrapati S, Sahu A, Bais S. A comparative study of bupivacaine vs ropivacaine wound instillation through surgical drain for postoperative analgesia in modified radical mastectomy. *Breast Cancer Res Treat*. 2019;8(2):94–97.
11. Kinkelin I, Brocker EB, Koltzenburg M, Carlton MS. Localization of ionotropic glutamate receptors in peripheral axons of human skin. *Neurosci Lett*. 2000;283:149–152. doi:10.1016/S0304-3940(00)00944-7
12. Sawynok J. Topical and peripheral ketamine as an analgesic. *Anesthesia Analg*. 2014;119:170–178. doi:10.1213/ANE.0000000000000246
13. El Sherif F, Elmorabaa H, Fares KM, et al. Effect of ketamine instillation on acute and chronic post mastectomy pain, a dose finding clinical study. *Open J Anesthesiol*. 2022;12(4):146–159. doi:10.4236/ojanes.2022.124013
14. Moharari RS, Najafi A, Khajavi MR, Moharari GS, Nikoobakht MR. Intraurethral instillation of ketamine for male rigid cystoscopy. *J Endourol*. 2010;24(12):2033–2036. doi:10.1089/end.2010.0193
15. Nejati A, Golshani K, Lakeh MM, Khashayar P, Moharari RS. Ketamine improves nasogastric tube insertion. *Emerg Med J*. 2010;27(8):582–585. doi:10.1136/emj.2009.075275
16. Fredman B, Zohar E, Tarabykin A, et al. Bupivacaine wound instillation via an electronic patient-controlled analgesia device and a double-catheter system does not decrease postoperative pain or opioid requirements after major abdominal surgery. *Anesth Analg*. 2001;92(1):189–193. doi:10.1097/00000539-200101000-00036
17. Talbot H, Hutchinson SP, Edbrooke DL, Wrench I, Kohlhardt SR. Evaluation of a local anaesthesia regimen following mastectomy. *Anaesthesia*. 2004;59(7):664–667. doi:10.1111/j.1365-2044.2004.03795.x
18. Black ND, Stecco C, Chan VWS. Fascial plane blocks: more questions than answers? *Anesth Analg*. 2021;132(3):899–905. doi:10.1213/ANE.0000000000005321
19. Rahimzadeh P, Imani F, Faiz SHR, Boroujeni BV. Impact of the ultrasound-guided serratus anterior plane block on post-mastectomy pain: a randomised clinical study. *Turk J Anaesthesiol Reanim*. 2018;46(5):388–392. doi:10.5152/TJAR.2018.86719
20. Sinha C, Kumar A, Kumar A, Prasad C, Singh PK, Priya D. Pectoral nerve versus erector spinae block for breast surgeries: a randomised controlled trial. *Indian J Anaesth*. 2019;63(8):617–622. doi:10.4103/ija.IJA_163_19
21. El Ghamry MR, Amer AF. Role of erector spinae plane block versus paravertebral block in pain control after modified radical mastectomy. A prospective randomised trial. *Indian J Anaesth*. 2019;63(12):1008–1014. doi:10.4103/ija.IJA_310_19

22. Mohamed SA, Sayed DM, Sherif FAE, El-Rahman AMA. Effect of local wound infiltration with ketamine versus dexmedetomidine on post-operative pain and stress after abdominal hysterectomy, a randomized trial. *Eur J Pain*. 2018;22(5):951–960. doi:10.1002/ejp.1181
23. Javid MJ, Rahimi M, Keshvari A. Dissociative conscious sedation, an alternative to general anesthesia for laparoscopic peritoneal dialysis catheter implantation: a randomized trial comparing intravenous and subcutaneous ketamine. *Peritoneal Dialysis Int*. 2011;31(3):308–314. doi:10.3747/pdi.2010.00110
24. Othman AH, El-Rahman AM, Sherif FE. Efficacy and safety of ketamine added to local anesthetic in modified pectoral block for management of postoperative pain in patients undergoing modified radical mastectomy. *Pain Physician*. 2016;19(7):485–494.
25. Honarmand A, Safavi M, Karaky H. Preincisional administration of intravenous or subcutaneous infiltration of low-dose ketamine suppresses postoperative pain after appendectomy. *J Pain Res*. 2012;5:1–6. doi:10.2147/JPR.S26476
26. Gorgias NK, Maidatsi PG, Kyriakidis AM, Karkoulas IKA, Alvanos DN, Giala MM. Clonidine versus ketamine to prevent tourniquet pain during intravenous regional anesthesia with lidocaine. *Reg Anesth Pain Med*. 2001;26:512–517. doi:10.1053/rapm.2001.27857
27. Abdel-Ghaffar HS, Kalefa MA, Imbaby AS. Efficacy of ketamine as an adjunct to lidocaine in intravenous regional anesthesia. *Reg Anesth Pain*. 2014;39(5):418–422. doi:10.1097/AAP.0000000000000128
28. Apfel C, Kranke P, Eberhart L, Roos A, Roewer N. Comparison of predictor models for postoperative nausea and vomiting. *Br J Anaesth*. 2002;88:234–240. doi:10.1093/bja/88.2.234
29. Ruiz JR, Kee SS, Frenzel JC, et al. The Effect of an anatomically classified procedure on antiemetic administration in the postanesthesia care unit. *Anesth Analg*. 2010;110(2):403–409. doi:10.1213/ane.0b013e3181a9d076
30. Le TP, Gan TJ. Update on the management of postoperative nausea and vomiting and postdischarge nausea and vomiting in ambulatory surgery. *Anesth Clin*. 2010;28(2):225–249. doi:10.1016/j.anclin.2010.02.003
31. Gan TJ, Meyer T, Apfel C, et al. Society for Ambulatory Anesthesia guidelines for the management of PONV. *Ambulatory Anesthesia*. 2007;105(6):1615–1627.
32. Fujii Y. Prophylaxis of postoperative nausea and vomiting in patients scheduled for breast surgery. *Clin Drug Investigation*. 2006;26(8):427–437. doi:10.2165/00044011-200626080-00001
33. Bakshi SG, Jibhkate B, Sareen R, Badwe R. Nausea and vomiting after breast cancer surgery, and relationship with tumor receptor status. *J of Anesthesia*. 2012;26(2):187–195. doi:10.1007/s00540-011-1274-5

Local and Regional Anesthesia

Dovepress
Taylor & Francis Group

Publish your work in this journal

Local and Regional Anesthesia is an international, peer-reviewed, open access journal publishing on the development, pharmacology, delivery and targeting and clinical use of local and regional anesthetics and analgesics. The journal welcomes submitted papers covering original research, basic science, clinical studies, reviews & evaluations, guidelines, expert opinion and commentary, case reports and extended reports. The manuscript management system is completely online and includes a very quick and fair peer-review system, which is all easy to use. Visit http://www.dovepress.com/testimonials.php to read real quotes from published authors.

Submit your manuscript here: https://www.dovepress.com/local-and-regional-anesthesia-journal