



Application of Lidocaine Jelly on Chest Tubes to Reduce Pain Caused by Drainage Catheter after Coronary Artery Bypass Surgery

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The objective of this study was to assess the effect of lidocaine jelly application to chest tubes on the intensity and duration of overall pain, chest tube site pain and the required analgesics for postoperative pain relief in coronary artery bypass graft (CABG) patients. For patients in group L, we applied sterile 2% lidocaine jelly on the chest tubes just before insertion, and for patients in group C, we applied normal saline. Overall visual analogue scale (VAS), maximal pain area with their VAS were documented postoperatively, and the frequency that button of patient-controlled analgesia was pressed (FPB) and total fentanyl consumption were assessed. The number of patients who complained that tube site was the most painful site was significantly higher in group C than in group L (85% vs. 30% at extubation, $P < 0.001$). The overall VAS score was significantly higher in group C than in group L (39.14 ± 12.49 vs. 27.74 ± 13.76 at extubation, $P = 0.006$). After all of the tubes were removed, the VAS score decreased more in group C (5.74 ± 4.77 , $P < 0.001$) than in group L (3.05 ± 2.48 , $P < 0.001$). FPB and total fentanyl consumption were significantly higher in group C than in group L (73.00 , 59.00 – 78.00 vs. 34.00 , 31.00 – 39.25 , $P < 0.001$; $2,214.65 \pm 37.01$ vs. $1,720.19 \pm 361.63$, $P < 0.001$, respectively). Lidocaine jelly application is a very simple way to reduce postoperative pain by reducing chest tube site pain after CABG. (Clinical Trials Registry No. ACTRN 12611001215910)

Keywords: Coronary Artery Bypass; Pain, Postoperative; Analgesia

INTRODUCTION

Pain management after cardiac surgery is very important to enhance the deep breathing, coughing, and early ambulation which are critical for respiratory care, early recovery and prognosis (1-3). Although pain after cardiac surgery is less than upper abdominal surgery and thoracotomy as less muscle division is required during median sternotomy (4), the sternal splitting causes significant pain. In addition to that, drainage catheter insertion sites are maximal painful locations after cardiac surgery (5, 6). Pain at the chest tube drainage sites decreases significantly after the tube removal (6) suggesting that adequate tube site pain control has an important role in overall pain management after cardiac surgery.

Pre-emptive analgesia is defined as an anti-nociceptive treatment that prevents the establishment of altered central processing of afferent input (7). This is used to reduce post-operative pain, analgesic consumption, and the development of subsequent complications (8).

Many clinical studies have demonstrated that the inhibitory effect of pre-emptive analgesia on the development of post-traumatic hyperalgesia results in reduction of post-operative

pain and total analgesic requirement (9). However, no study has investigated the effects of local anesthetic application to chest tube on pain after coronary artery bypass graft (CABG).

We hypothesized that the application of lidocaine jelly to the chest tube will reduce pain at the chest tube insertion site, improving total pain after CABG. Therefore, the principal objective of this prospective, randomized study was to assess the effect of lidocaine jelly application to chest tubes on intensity and duration of overall pain, chest tube sites pain and the required analgesics for postoperative pain relief in CABG patients.

MATERIALS AND METHODS

Patients

The patients who underwent coronary artery bypass surgery (CABG) by a single surgeon at hospital from January 2009 to July 2011 were candidates for inclusion in this study. These criteria included age from 18 to 65 yr, and first time full median sternotomy for CABG.

Patients who had an emergency surgery, perioperative intra-aortic balloon pump, extracorporeal membrane oxygenator, re-operation for bleeding, additional postoperative drainage catheter

ter insertion, postoperative cognitive dysfunction, an allergy to local anesthetics and side effects to acetaminophen were excluded. Patients who underwent CABG using the bilateral internal mammary arteries or the single left internal mammary artery with non-skeletonized fashion, patients who were extubated after the first operative day morning and patients who were enrolled to other clinical studies were excluded. Further exclusion criteria were evidence of preoperative opioid medication or psychiatric medical history. The decisions to enroll and exclude patients were made by the investigator, who did not otherwise participate in conducting the study and data collection.

Study design and randomization

In this study, randomization into one of the two groups was based on Excel (Microsoft®, Seattle, WA, USA) random-number generation. The details of the series, which were generated by a statistician who did not participate in this study, were unknown to the investigators and the patients, and the numbers were contained in a set of sealed envelopes. During operative procedure, after making incisions and pathways for the chest tubes, the numbered envelope was opened and the card inside determined patient group assignment.

For patient in group L (lidocaine jelly group), we applied sterile 2% lidocaine jelly (Korea Arlico Pharm, Seoul, Korea) on whole length of the chest tubes just before insertion which was sufficient amount so that the jelly remained at the insertion sites and the tube and chest wall contact sites. For patient in group C (control group), we applied normal saline on the chest tubes.

Anesthesia and surgical technique

All of the patients underwent CABG using the skeletonized left internal mammary artery and the great saphenous veins under standard cardiopulmonary bypass with moderate hypothermia. Anesthesia was performed following the standards established in our institution. Patients received standardized total intravenous anesthesia using propofol, remifentanyl and rocuronium administered by the same anesthesiologist. The same sternal spreader was used in all patients. Two chest tubes for mediastinal drainage were inserted via the rectus abdominis muscles just below the xyphoid area. Chest tubes for pleural drainage were inserted via intercostal space along the midclavicular line. Chest tubes to drain the left pleural space were placed in all patients and the right pleural tubes were placed as required. Diameter of all tubes was 28 French. The sternum was closed with 7 sternal wires.

Post-operative pain control

To control the post-operative pain, intravenous fentanyl with a computerized intravenous patient-controlled analgesia (PCA) system (Automed 3300TM; ACE Medical Corp. Ltd., Seoul, Korea) was used. PCA was set to give intravenous fentanyl 0.2 µg/

kg/hr continuously, 0.4 µg/kg as bolus when the patient pushes the button. The patients were taught to push the button of the PCA system to get a bolus of drug each time pain occurred. The PCA was locked out for 15 min when the button was pushed for the bolus dose. In the case of persistent pain greater than a visual analogue scale (VAS) pain score of 40/100, an additional 50 µg of fentanyl was injected intravenously by the investigator until the VAS pain score became lower than 40/100. PCA was applied until third postoperative day, and two tablets of 650 mg acetaminophen were given as oral pain control regimen from fourth postoperative day to seventh postoperative day. All data on timing, FPB were recorded in a computed PCA and transferred to a personal computer for analysis.

Study variables

For each patient, the age, gender, the duration of operation (from skin incision to closure), and the extubation time were recorded. Before surgery, for measuring pain, the patients were instructed to use a 100-mm VAS (VAS with the endpoints labeled 'no pain' and 'the worst possible pain').

Overall VAS (defined as VAS of whole body in general, regardless of specific pain location), maximal pain area with their VAS was documented on first, second, third and seventh postoperative day in the morning. VAS scores were collected by one blinded investigator with three years of experience for postoperative pain interview. The protocols to instruct use of VAS and check the intensity of pain were standardized.

Additional analyses were performed with regard to the FPB and the fentanyl consumption of the PCA system. The FPB was assessed for 3 intervals (0 to 1st, 1st to 2nd, 2nd to 3rd operative day).

The amount of additional intravenous fentanyl was evaluated and the integrated fentanyl consumption (sum of PCA delivered and additional intravenous bolus fentanyl) was assessed at the same time intervals for each patient. The total amount of injected fentanyl and FPB for 3 days was compared between the groups.

Satisfaction scores were obtained at discharge with regard to pain control and with the overall recovery process (11 numeric rating scale in which 0 = 'very dissatisfied' and 10 = 'very satisfied').

Sample size calculation

This study was designed to be a superiority clinical trial. Primary end point of this study was overall VAS pain score. To estimate the group size, a pilot study was conducted for measuring the overall VAS pain score in 10 patients in whom normal saline applied chest tubes were placed. The VAS pain scores at extubation and on first, second, third, and seventh postoperative day were 40.2 ± 10.4 , 34.2 ± 9.9 , 29.4 ± 8.9 , 22.6 ± 8.7 , and 13.5 ± 7.2 respectively and autocorrelation between adjacent measurements on the same individual of 0.6. For our power calculation, we assumed that first-order autocorrelation adequately repre-

sented the autocorrelation pattern. We wanted to detect a 10% difference in the VAS pain score between groups. Therefore, with an α of 0.05 and a power of 80%, we needed 22 patients per group. Considering a compliance rate of 90%, we enrolled 50 patients in this study. The PASS 11™ software (NCSS, Kaysville, UT, USA) was used to calculate the sample size.

Statistics

We used an intention to treat strategy—that is, all participants were included in the analysis irrespective of whether they had completed the study. Two options were considered when dealing with missing values: baseline values carried forward for missing data; missing data replaced with average of other group at that time point. The most painful site was analyzed using as-treated strategy.

For the continuous variables, the normal distribution of the collected data was first evaluated using the Shapiro–Wilk test. The normally distributed data is presented as the mean \pm standard deviation and the groups were compared using parametric test. The non-normally distributed data is expressed as medians (interquartile range) and the data was analysed using the non-parametric test.

Overall pain score and pain score at the most painful site were normally distributed and passed the Sphericity test, repeated-measures analysis of variance was used to evaluate their differences, followed by a Tukey test for multiple comparisons. Fentanyl consumption, frequency of Button Pushing for PCA were abnormally distributed ($P < 0.05$), Friedman's repeated-measures

analysis of variance was used to evaluate their differences, followed by a Bonferroni correction.

Descriptive variables were subjected to chi-squared analysis or Fisher's exact test, as appropriate. Data in the figure were expressed as mean \pm standard error. Null hypotheses of no difference were rejected if P values were less than 0.05. Statistical analysis was performed using SPSS version 18.0 (IBM Corp., Armonk, NY, USA).

Ethics statement

This study was approved by the institutional review board of the College of Medicine of Chung-Ang University (C2010049-344) and was registered with the Australian New Zealand Clinical Trials Registry or Clinical Trial (ACTRN12611001215910). This study was carried out according to the principles of the Declaration of Helsinki, 2000. We performed a prospective, randomized, controlled study, and informed written consent was obtained from each patient before inclusion in the study.

RESULTS

Among 50 patients who were asked to be enrolled in the study, five of them declined to participate. Of the 45 patients included, 23 patients were randomized to group C and 22 patients to group L. Three patients were excluded from this study. One of two patients in group C was excluded because of extubation after the first postoperative day morning and the other one was excluded for reoperation. One patient in group L was excluded because of postoperative use of intra-aortic balloon pump (Fig. 1).

There was no postoperative infection. There was no surgical mortality in the both groups. There were no differences in demographic data between the two groups (Table 1).

The number of patients who complained that the chest tube site was the most painful site was significantly higher in group C than in group L during the study (Table 2). Overall VAS score was

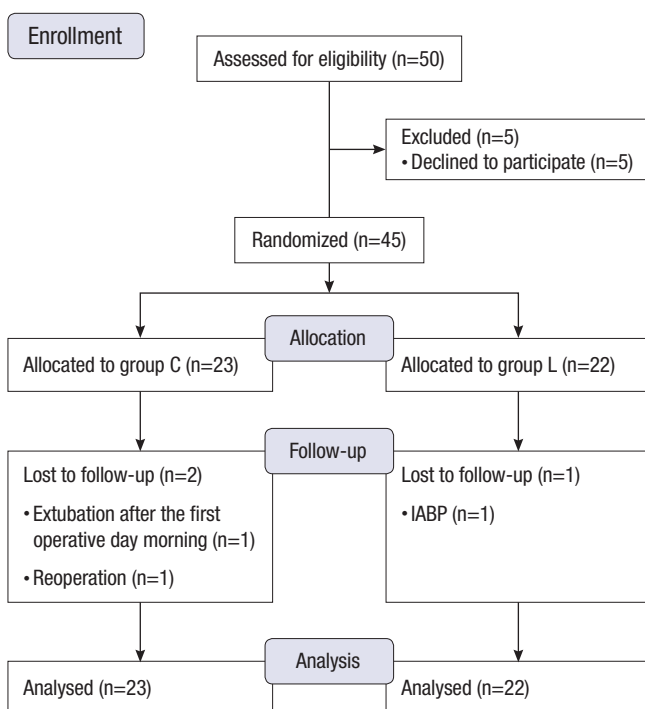


Fig. 1. A CONSORT Diagram. IABP, intra-aortic balloon pump.

Table 1. Demographic data by group

Parameters	Group C (n = 23)	Group L (n = 22)	P value
Age (yr)	68.00 (52.00-71.00) [60.49-69.69]	68.50 (52.00-71.50) [57.56-67.44]	0.715*
Gender M/F (No.)	16/7	14/8	0.673
Height (cm)	161.74 \pm 8.45 [158.08-165.39]	161.64 \pm 11.89 [157.43-165.84]	0.759
Weight (kg)	62.83 \pm 10.46 [58.31-67.36]	64.24 \pm 11.89 [58.59-69.14]	0.970
Duration of Op (min)	275.00 (215.00-320.00) [250.15-342.46]	310.00 (233.75-360.00) [266.62-332.93]	0.460*
Extubation time (min)	385.00 (330.00-950.00) [421.29-780.88]	417.50 (315.00-960.00) [452.54-977.00]	0.540*

Values are expressed as mean \pm SD [95% confidence interval], median (interquartile range) [95% confidence interval] or absolute number. *Mann-Whitney U test is used and expressed as median (interquartile range) [95% confidence interval] because of abnormal distribution. M, male; F, female; Op, operation.

significantly higher in group C than in group L until the third postoperative day (Fig. 2). In the both groups, the pain gradually diminished during the recovery period.

The VAS score at the most painful area decreased gradually in the both groups. However, the VAS score at the most painful site was significantly higher in group C than in group L until the third postoperative day. This difference disappeared on seventh post-

Table 2. The number of patients who complained tube site as the most painful site

	Group C (n = 23)	Group L (n = 22)	P value
Ex	17 (85%)	6 (30%)*	< 0.001
Pod1	16 (80%)	7 (35%)*	0.004
Pod2	12 (60%)	5 (25%)*	0.025
Pod3	13 (65%)	5 (25%)*	0.011
Pod7	8 (40%)	2 (10%)*	0.028

Values are expressed as absolute number (%). *P < 0.05 compared with Group C. Ex, at extubation; Pod, postoperative day.

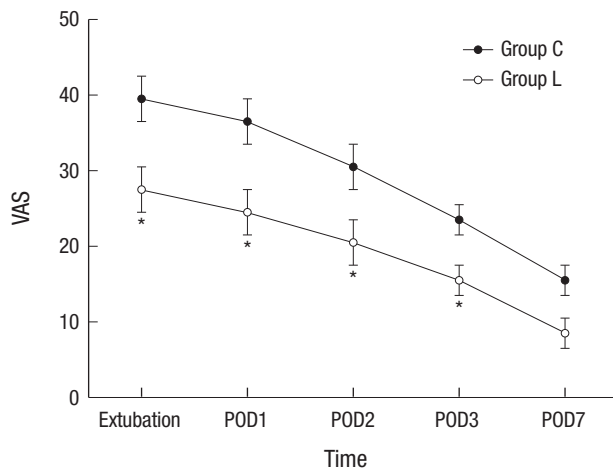


Fig. 2. Overall pain score. VAS, visual analogue scale; POD, postoperative day. Values are expressed as mean ± SE. *P < 0.05 compared with group C.

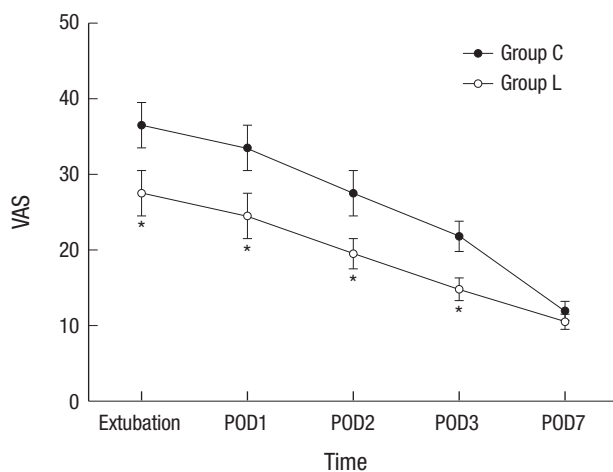


Fig. 3. Pain score at the most painful site. VAS, visual analogue scale; POD, postoperative day. Values are expressed as mean ± SE. *P < 0.05 compared with group C.

operative day (Fig. 3).

There was no difference of day of all the tubes removed in the both groups (2.52 postoperative day in group C, 2.68 postoperative day in group L; P = 0.279). Overall VAS score before the tubes removal was significantly higher in group C than in group L. Overall VAS score decreased after all the tubes removal in the both groups. However, the VAS score decreased more in group C and statistical significance in overall VAS score between the groups disappeared after tube removal (Fig. 4).

There was moderate correlation between overall VAS and FPB (r = 0.358, P < 0.001). Overall VAS and fentanyl consumption correlated (r = 0.219, P = 0.011) as well but weakly.

Total amount of fentanyl use and total FBP were lower in group C than group L, however no significant difference was noted between the groups with regard to the satisfaction score (Table 3).

DISCUSSION

The results of this trial indicate that lidocaine jelly application to the chest tube significantly reduced pain and the opioid con-

Table 3. Total amount of fentanyl use and frequency to push the button of PCA

Items	Group C (n = 23)	Group L (n = 22)	P value
Fentanyl (µg)	2,214.65 ± 337.01 [2,068.91-2,360.39]	1,720.19 ± 361.63 [1,559.85-1,880.53]	< 0.001
FPB (number)	73.00 (59.00-78.00) [61.96-74.99]	34.00 (31.00-39.25) [†] [35.21-40.23]	< 0.001*
Satisfaction score (0-10)	7.00 (5.00-7.00) [5.68-7.02]	7.00 (6.00-8.00) [6.46-7.63]	0.119*

Values are expressed as mean ± SD, or median (interquartile range) [95% confidence interval]. *Mann-Whitney U test is used and expressed as median (interquartile range) [95% confidence interval] because of abnormal distribution; †P < 0.05 compared with Group C. PCA, Patient-controlled analgesia machine; FPB, frequency to push the button of PCA.

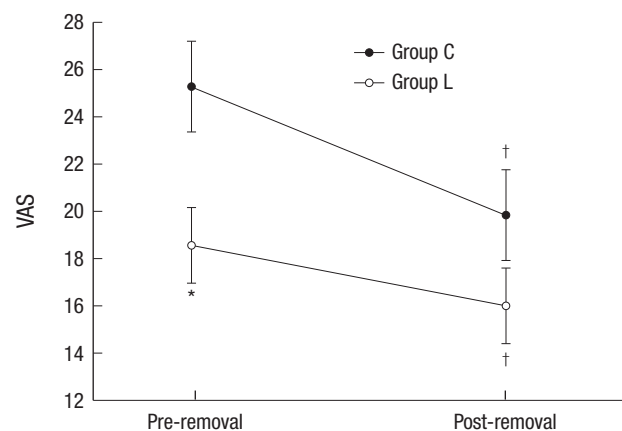


Fig. 4. Overall pain score before and after the tubes removal. VAS, visual analogue scale. Values are expressed as mean ± SE. *P < 0.05 compared with group C; †P < 0.05 compared with before tube removal.

sumption in patients who underwent CABG. The overall VAS scores, the VAS score at most painful area, fentanyl consumption, and FPB were lower in group L than that in group C until the 3rd postoperative day. Total fentanyl consumption (sum of PCA delivered and additional intravenous bolus fentanyl) was 23% less in group L, which reflects better objective patient satisfaction in terms of pain.

Tissue and peripheral nerve injury leads to a local inflammatory reaction accompanied by increased levels of proinflammatory cytokines, which induces the peripheral and central nervous system sensitization that leads to hyperalgesia (10). Lidocaine is an amide local anesthetic that has many pharmacological properties such as anti-arrhythmic (11), analgesic (12), and anti-inflammatory properties (13). We think that those properties of lidocaine reduced overall pain and pain at the chest tube insertion sites as a pre-emptive analgesic.

Postoperative analgesics are used to control pain after the pain develops. In contrast to that, pre-emptive analgesia, such as lidocaine jelly in the study, blocks pain before it is produced by surgical procedure. It has been already known that pre-emptive analgesia is very effective to reduce post-operative pain, analgesic consumption, and the development of subsequent complications (8, 9). In this study, the reduction of the overall VAS pain score, VAS score at the most painful area, FPB and fentanyl consumption persisted beyond the third postoperative days. This noticeable prolongation of the analgesic effect beyond the duration of lidocaine's effect (14) might be related to the prevention of central or peripheral hypersensitivity (15).

This study showed that VAS score closely corresponded with PCA data such as FPB. This suggested that computed PCA data can be used as additive or alternative to VAS score as a tool to measure subjective pain.

There was no difference in mortality and morbidity in the both groups even though there was significant pain reduction with lidocaine jelly application. Someone can argue that pain reduction with lidocaine jelly was not sufficient to be clinically significant in terms of mortality and morbidity in the study. However, we think that pain reduction would have been clinically significant in terms of mortality and morbidity as well if the study had been performed in larger scale.

One striking feature that we found out in this study is that more patients (85% in group C, 30% in group L just after extubation) than we thought indicated tube insertion site as the most painful site. This means that we have to focus on chest tube site pain control more to reduce postoperative pain.

We think the pain caused by drainage tube after surgery can be from skin incision, rubbing during the tube insertion and continuing irritation between adjacent tissue and the tube. We do not know which step mainly causes pain. We assume that analgesic effect and lubricant effect of lidocaine might have their roles to reduce pain.

Lidocaine jelly application is very easy and simple to perform. And, it does not add any significant risk and time to operation. In the study, there was no wound complication and infection in both group. After the study, we are applying lidocaine jelly to all patients who undergoes heart operation. We assume that other topical analgesic agents might have similar effect although further study is needed.

In spite of the early positive analgesic effects of lidocaine jelly application, there were no differences between the two groups in Likert satisfaction score for postoperative pain control at discharge. The potential reasons for the inability to clinically establish the effect of early positive analgesic results on Likert satisfaction score could be an inadequate pain control design and the complex and multifactorial nature of pain.

There are some limitations of the study. First, to prevent unnecessary jelly entering the patient, we used saline in group C instead of using jelly which looks similar to lidocaine jelly. This made the surgeon not blind to the study. However, we thought that usage of any type of lubricant jelly in group C just to make the surgeon blind to the study was not justified. Although, it was not possible to keep the surgeon blind to the study at the end of the operation in order to protect the patients, all the other investigators who measured the pain and analyzed the data were completely blind to the study. Second, sample size may be insufficient to detect other differences such as morbidity and mortality between the both groups than primary outcome measure. However, as the purpose of the study was to investigate the pain after CABG, we calculated sample size for the pain measurement in order to enroll the least number of patients required to obtain enough statistical power. Third, we excluded patients with co-morbidity from this study. Therefore, the results cannot be extrapolated to all patients, nor can rare complications be ruled out completely.

On the other hand, some advantages of the current study are worth highlighting. We included only CABG in our study to avoid the type, nature and duration of pain associated with different types of surgery. Moreover, all surgeries were performed by the same surgeon to minimize the differences in tissue handling. Furthermore, all observations were assessed by a single observer to eliminate any inter-observer variability. Thus, we can assume that the difference in pain relief reflects only the effectiveness of the antinociceptive measures.

In conclusion, lidocaine jelly application is very simple way to reduce pain caused by chest tube after CABG.

DISCLOSURE

The authors have no conflicts of interest to disclose.

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