Continuous Local Infusion of Bupivacaine with ON-Q Pump System for Pain Management after Median Sternotomy

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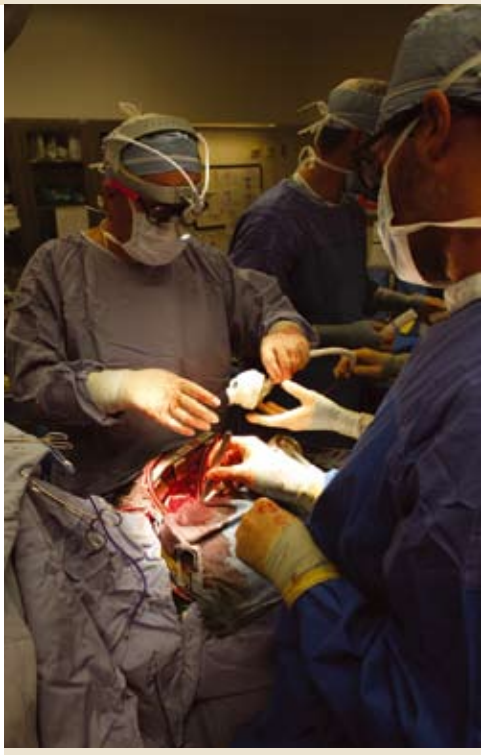

Abstract

Background: Postoperative pain remains as a challenging case despite improvement of analgesic techniques. It may also increase the rate of morbidity and even mortality. Local anesthesia may decrease the consumption of opioids and its potential side effects. This study was aimed to show the role of local anesthesia in post-sternotomy pain.

Methods: This prospective randomized clinical trial includes 40 candidates for elective coronary artery bypass graft (CABG) surgery. Patients with diabetic mellitus and other major co-morbidities were excluded. In group A (20 patiens) Bupivacaine 0.25% was continuously infused into subcutaneous tissue using the ON-Q system (I-flow Corporation, Lake Firest CA, USA) (2ml/h for 72h). Group B patients did not receive local anesthetics. The intensity of pain in was measured using Visual Analogue Scale (0-10). Need for narcotics or other analgesics, hemodynamic and arterial blood gas profiles were also recorded.

Results: Both groups were similar regarding age, sex, body mass index, smoking and drug addiction and operative characteristics. The mean visual analogue scale (VAS) was significantly lower in G.A than G.B (2.1+/-1.7 versus 4.3+/-2.7) (P=0.005). Narcotics requirement in G.A had decreased 25% compared to G.B (P= 0.041) but the mean doses of opioids consumption had no significant difference in two groups. Most of the patients in G.A (85%) were fully satisfied from his pain control, while this rate was only 45% in G.B (P= 0.029). Regarding other post-operative complications, both groups were identical and no significant difference was observed. Days of stay in hospital was reduced 1.4 days in average which is not significant (P=0.06). Drug addicts required higher doses of narcotics.

Conclusion: Continuous local infusion of Bupivacain with ON-Q pump system can be useful and safe for pain management after median sternotomies. Bupivacaine not only reduces the pain intensty, but also reduces the consumption of opioids and other analgesics when compared to the control group. It also seems that this method may reduce the length of hospitalization and hence the hospital charges.

Key words: IPain, CABG, Local Anesthesia, ON-Q Pump, Bupivacaine

Introduction: Post-operative pain is one of the complications of the cardiac surgery which can increase the morbidity and mortality rates. The effects of post-operative pain not only influence the result of the surgery, but also may result in high blood pressure, tachycardia and reduction of myocardial performance (1-2).

Prevention and treatment of post-operative pain and its complications is one of the main issues in post-operative cares and plays an important role in expediting the improvement of the patients' general condition (1). Opioid analgesics are considered as the basic treatment in controlling the post-operative pain. However, due to known side effects of these medications, several efforts have been done to reduce the need for opioid analgesics by finding out new analgesics as well as new methods for reducing the post-operative pain (1).

The pain intensity after sternotomy has its peak at the first two days after the operation, especially when the patient is staying in ICU (3).

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In most cases, intravenous use of opioid analgesics is the most common method to reduce the post-operative pain. These drugs can be use either through the nursing controlling systems or the patients themselves (4). However, controlling the pain by intravenous opioids has its own disadvantages like breathing depression and delay in extubation. Furthermore, the opioid analgesics can give rise to GI tract side effects (nausea, vomiting and illeus) and urinary retention (5,6,8).

In recent years, new methods have been introduced to reduce the post-operative pain and need for opioid analgesics in cardiac surgery. A part of the success includes subcutaneous infusion methods which are easily tolerated by the patients. Some new surgical approaches such as lateral thoracotomy, partial sternotomy, etc. have been also introduced to decrease the pain and complications after cardiac surgery (9). Robotic surgery is one of the latest efforts to reduce the traumas resulting from surgery (10). Thoracic epidural anesthesia or patient controlled systems have been used for a better control of the post-operative pain (11). Infiltration or continuous infusion of Bupivacaine in surgical wound has been shown as effective way to postoperative pain control. Although use of this method has started in 90s, limited studies are available in regard with efficacy of local infusion of Bupivacaine in reducing the pain after median sternotomy. Furthermore, there are some disagreements in the results (3).

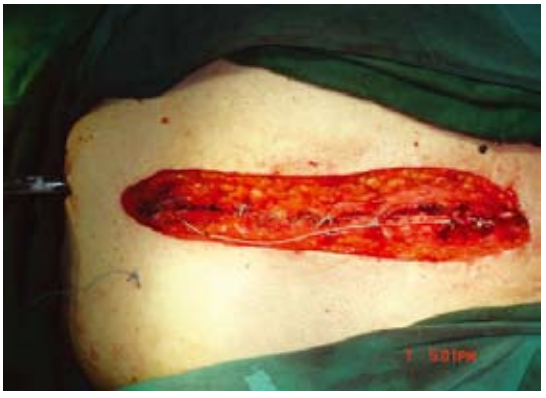
In present study, we tried to show the efficacy of local infusion of Bupivacaine in reducing the post-operative pain using a new auto infusion pump system after median sternotomy.

Methods:

This study has been designed as a prospective single blind randomized clinical trial. The study population was patients underwent elective coronary artery bypass grafting surgery at Rajaee Heart Center of Tehran. After obtaining approval from ethic committee of institute and informed consent from the patients they enrolled in the study. The exclusion criteria included patients with diabetes mellitus, known allergies to Bupivacaine, previous sternotomy, neuropsychological disorders and who was unrelible. We also excluded whom supposed to be high risk for long intubation or sedation including sever LV dysfunction (LVEF<=25%), sever COPD (FEV1< 1.5 lit/s), concomitant valve procedure.

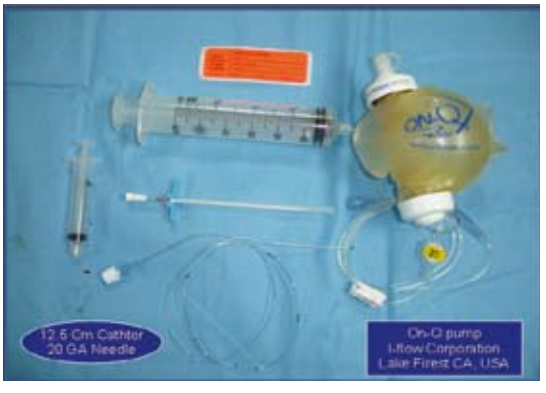
They were randomized into two groups (Group A= case, Group B=Control) based on block randomization method. Each groups included 20 patients. All these patients received the same general anesthesia technique using Midazolam, Atracurium and Sufentanil for both induction and maintenance of anesthesia. In group A a soft small diameter catheter (20 GA, 12.5 Cm Catheter) with several side holes of the ON-Q pump system (I-flow Corporation, Lake Firest CA, USA) was placed in soft pre-sternal tissue at the end of procedure just after closing the sternum. Because the most patients complain from pain in the lower part of the wound near the substernal drain location, the head of the catheter which had a hole was directed to the lower part of incision in form of a loop (Fig.1).

Figure1: *Placement of On-Q pump fine catheter for subcutaneous infusion.*



The subcutaneous tissue and skin was repaired in standard fashion. The autoinfusion elastometric pump of ON-Q system was filled by 240 mg of Bupivacain and 125 ml of normal saline (Fig. 2).

Figure2: ON-Q infusion pump system



The continuous infusion rate of the pump was 2 ml/h that took about 72 hours. For group B patients no catheter was placed and no drug was injected.

The postoperative pain intensity was scored based on visual analogue scale (VAS) ranging from 0 (no pain at all) to 10 (the most severe pain the patient has ever had). Patients' pain relief was also scored from 0-10. We defined as complete satisfaction when the score was 0-3, partially satisfaction when was 4-7 and the patient considered unsatisfied from his pain relief management when the score was 8-10.

The primary data of patients including age, sex, history of opium addiction, bone density of the sternum (I: normal density, II: mild osteoporosis and III. severe osteoporosis), number of grafts, number of chest drains, subcutaneous fat thickness (<10mm, 10-30 mm, >30 mm), iatrogenic fracture of the sternum or ribs, the cardiothoracic ratio were recorded. We also collected the postoperative data including doses of narcotic and other analgesics, duration of mechanical ventilation & intubation time, heart rate, respiratory rate, blood pressure, Pao2 and Paco2 in two different time (I: first hour of ICU admission, II: Just before ICU dismissal).

These data were analyzed using the SPSS version 15 statistical software. The quantitative data have been shown as mean +/- standard deviation, and the qualitative data have been presented in terms of frequency. In order to compare the quantitative and qualitative data of two groups with normal distribution, we used the k2 for qualitative variables, and the t-test for quantitative variables. Nonparametric tests were used to compare the variables that had not normal distribution. . The level of significance had been considered 0.05.

Results:

In this study we had 40 patients, twenty cases in each groups. Two patient's groups were similar in demographic data including age, sex, B.S.A, history of smoking & drug addiction, previous myocardial infarction and involvement of coronary arteries (Table 1).

Table1: *Demographic data of the patients in two study groups.*

		Group A (Case)	GroupB (Control)	P Value
Age, Yr.	(Mean+/-SD)	57.2 +/- 9	57.9 +/- 8	0.80
Sex	(Male/Female)	16 / 4	18 / 2	0.37
BSA	(Mean+/-SD)	1.84 +/-0.1	1.83 +/- 0.1	0.48
Smoker,	No (%)	8 (40%)	14 (70%)	0.05
Addiction,	NO (%)	7 (35%)	9 (45%)	0.51
Previous MI,	No.(%)	13 (65%)	9 (45%)	0.20
Pre-op LVEF	(%)	41.3+/-8	41.2+/- 7	0.63
CAD:				0.39
	SVD	1	1	
	2VD	4	3	
	3VD	15	16	

Also there were no significant statistically differences in operative data between two groups (Table 2); so we had a well matched two study populations.

Table2: *Operation Characteristics between two Study Groups.*

	Group A (Case)	GroupB (Control)	P Value
CABG* Type: No.			0.50
Conventional OPCAB	12 8	14 6	
Graft No.(Mean)	2.55 +/- 0.9	2.65 +/- 0.6	0.42
CPB** Time,min. (mean+/SD)	77.5 +/- 19	73.5 +/- 21	0.63
AOX# Time,min (mean+/SD)	42.8 +/- 11	38.7 +/- 14	0.43
Drain No. (%)			0.77
1 (mediastinum)	5 (25%)	7 (35%)	
2 (Mediastinum+Left Pleura)	13 (65%)	11 (55%)	
3 (mediastinum+Both pleura)	2 (10%)	2 (1%)	
Bone Fracture, No. (%)	4 (20%)	5 (25%)	0.70
C/T*# Ratio (mean+/SD)	0.56 +/0.7	0.51 +/- 5	0.13

*Coronary Artery Bypass Graft, **Cardiopulmonary bypass, #Aortic Cross Clamp, *#Cardiothoracic

Table 3 shows that the postoperative complications,

Table3: *Postoperative findings between two study groups.*

	Group A (Case)	GroupB (Control)	P Value
Duration of sedation (Hour)	3.42 +/- 2	4.6 +/- 3.9	0.08
Duration of mechanical ventilation (Hour)	7.3 +/- 3.4	7.5 +/- 3.1	0.17
Duration of Intubation (Hour)	9.1 +/- 3.8	9.2 +/- 3.9	0.92
Duration of using drains (Hour)	46.2 +/- 15	41.4 +/- 9	0.60
ICU stay (Day) (mean+/-SD)	2.25 +/- 0.5	2.10 +/-0.3	0.90
Pos-op Pleural effusion (No)	3 (15%)	2 (10%)	0.28
Hospitalization (Day) (mean+/-SD)	6.3 +/- 1.3	7.7 +/- 3.1	0.06
Wound Problems	None	None	
Post-op Complications	None	None	
Post-op MI	-	-	
Neurological Problems	-	-	
Respiratory insufficiency	-	-	

ICU and hospital stay were statistically similar in two groups. Although the mean length of hospitalization was 1.4 days shorter in group A, this difference could not be considered significant (p=0.06). Meanwhile there were no significant difference in postoperative hemodynamic and arterial blood gas profiles between groups A & B (Table 4).

Table 4: *Blood gases & hemodynamic profiles of the patients*

	Group A (Case)	GroupB (Control)	P Value
PaO2 (mean+/-SD)	99.7+/-22	104+/-28	0.08
PaCO2 (mean+/-SD)	37.5+/-6	41+/-10	0.17
HR1* (mean+/-SD)	95+/-14	101+/-8	0.07
RR1** (mean+/-SD)	16+/-3	14+/-3	0.69
BP1*** (mean+/-SD)	120+/-17	131+/-23	0.11
HR2# (mean+/-SD)	90+/-13	99+/-5	0.06
RR2## (mean+/-SD)	18+/-3	18+/-5	0.53
BP2### (mean+/-SD)	120+/-12	124+/-30	0.81

*Heart rate at first hour of ICU stay
**Respiratory rate at first hour of ICU stay
***Blood pressure at first hour of ICU stay
#Heart rate before ICU dismissal
##Respiratory rate before ICU dismissal
###Blood pressure before ICU dismissal

The mean visual analogue scale (VAS) was significantly lower in Group A than Group B (2.1+/-1.7 versus 4.3+/-2.7) (P=0.005). This difference can be seen in figure 3. The mean doses of opioid agent based on Pethidine to control of patients' pain during ICU stay were 64+/-35 mg for Bupivacain group and 75+/-35 mg for control group, however this difference was not significant (P=0.057). In addition the rate of pain reduction in patients who had received Bupivacaine was significantly more than the patients in control group. The mean pain relief score was 7.9+/-6.1 in group A and 5.7+/-2.7 in group B (P=0.006).). Regarding satisfaction from the pain treatment after surgery, 85% of the patients in group A had a complete satisfaction, while in group B only 45% of the patients had a complete satisfaction (P=0.029) (figure 4). The need for narcotics during first postoperative day has decreased by 25% in group A compared to group B. Although this reduction was statistically significant (p=0.031), but there were no important difference in various doses of narcotics between groups (Table 5).

Table5: *Prevalence of different doses Opium need at first Post-op day at ICU Based on Pethidine in two groups.*

	Group A (Case)	GroupB (Control)	P Value
No need (first Post-op day)	11 (55%)	6 (30%)	0.03
25 mg	2 (10%)	1 (5%)	0.38
50 – 100 mg	3 (15%)	6 (30%)	0.06
100 - 150 mg	3 (15%)	3 (15%)	0.50
150 – 175 mg	None	2 (10%)	0.17
200 mg	1 (5%)	2 (10%)	0.41

We also compared the study groups considering the history of opium addiction. There were 7(35%) addict patients in group A and 9 (45%) in group B (P=0.87). Drug addicts had experienced more sever post sternotomy pain and the mean VAS was significantly higher in these patients (P=0.026) (6.3 +/-2.5 versus 3.8 +/-2.5). Meanwhile the prevalence of patients need for opiods to control of the postoperative pain was 80% in drug addicts but this rate was only 50% in non-addicts (P=0.002). Table 6 shows that the patients' opium addiction may have an important role in post sternotomy pain management.

Table6: *Different aspects of opium addiction in postoperative pain management.*

	Opium Addicts	Non-addicts	P Value
Dose of Opioids, mg. Mean (Range)	86.25+/-55 (25- 200)	64 +/- 37 (25 – 125)	0.04
Need for Opioid during 2th post-op Day	37.5% (6 / 16)	16.7% (4 / 24)	0.05
Patients' Satisfaction			0.009
Not satisfied	25.1%	12.5%	
Partially satisfied	18.8%	8.3%	
Complete satisfied	56.1%	79.2%	

In multivariate analysis, bone density, sternum or rib fracture, subcutaneous tissue thickness and number of mediastinal drains were not independent predictors for higher pain scores or higher doses of narcotic consumption during postoperative period. Although NSAIDs requirement in group A has decreased by 15% compared to group B, this decrease is not significant (P=0.451).

Discussion:

Prevention and treatment of post-operative pain and its complications is one of the challenging issues in post-operative cares. (1). Opioid analgesics are considered as the basic treatment in controlling the post-operative pain. However, controlling the pain by intravenous opioids has its own disadvantages like breathing depression and delay in extubation. Furthermore, the opioid analgesics can give rise to GI tract side effects (nausea, vomiting and illeus) and urinary retention (5,7,10). In recent years, new methods have been introduced to reduce the post-operative pain and need for opioid analgesics in cardiac surgery.

Continuous local infusion of Bupivacaine is one of thes

methods suggested to reduce the postoperative pain. This method has been successfully used in different surgeries. The first report in relation with the use of this method in cardiac surgeries was published by Magnano et al. in 2005 (10). This study showed that infiltration of Bupivacaine during a 36-hour continuous sub-cutaneous infusion did not have important role in reduction of postoperative pain or shortening the ventilation time compared to the control group and the recorded difference in pain score of the groups was not significant statistically. On the contrary, this study showed that the patients in the control group were extubated faster than those in Bupivacaine group. Meanwhile, blood gas analysis during the first 24 hours after the operation was better in the control group, although our study has proved the contrary. Magnano and his colleages provided several reasons for not getting a good result by infusion of Bupivacaine. First of all, the catheter used for infusion had few holes in the tip. This could be considered as a defect for large surgical incisions, such as median sternotomy. In fact, the lower parts of the wound have not been covered by the analgesic. Another reason focused by some authors is that the median sternotomy is a rather painless wound and most of the post operative pain in this approach related to iatrogenic trauma of the thoracic bones and the mediastinal drains (6,9). As already mentioned, in present study the location and number of drains, iatrogenic fracture of the sternal bone or ribs, bone density and subcutaneous tissue thickness were not independent predictive factors for post sternotomy pain intensity.

White and his colleagues showed that the continuous infusion of Bupivacaine 0.5% at a rate of 4 ml/h can considerably reduce the pain as well as the need for opioids. Furthermore, this method has increased the satisfaction of the patients in controlling the post operative pain and has therefore, reduced the length of their stay in hospital (11,12). In our study the length of hospitalization was 1.4 days shorter in the Bupivacaine group, but this reduction was not significant statistically. Patients' VAS were significantly lower and also patients' satisfaction were significantly higher (85% completely satisfied versus 45%) in Bupivacain group. The number of patients needed for opioid agents for control the postoperative pain were significantly lower, however there was not statistically significant difference regarding the mean dose of narcotics consumption for each patient.

Pain scores were significantly higher in opium addicts (6.8 versus 3.8). These patients more frequently required for opioids drugs (80% versus 50%) and they needed higher doses of opioids for pain relief.

In conclusion the results showed that using Bupivacaine not only reduces the patients' pain, but also reduces the consumption of opioids and other analgesics when compared to the control group. So the continuous local infusion of Bupivacain with ON-Q pump system can be useful and safe for pain management after Median Sternotomies. It also seems that this method may reduce the length of hospitalization and hence the hospital charges. It is clear that further double blind complementary studies are required to confirm these issues.

Acknowledgement:

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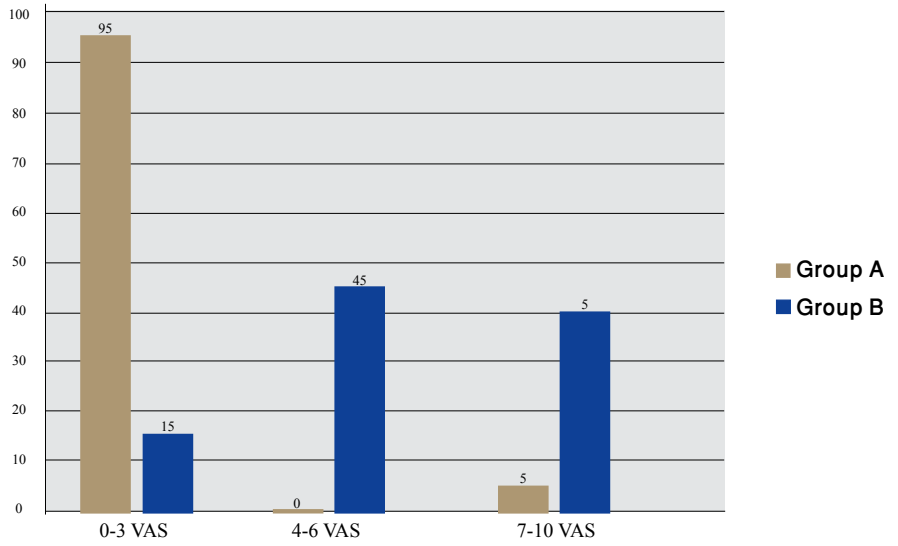
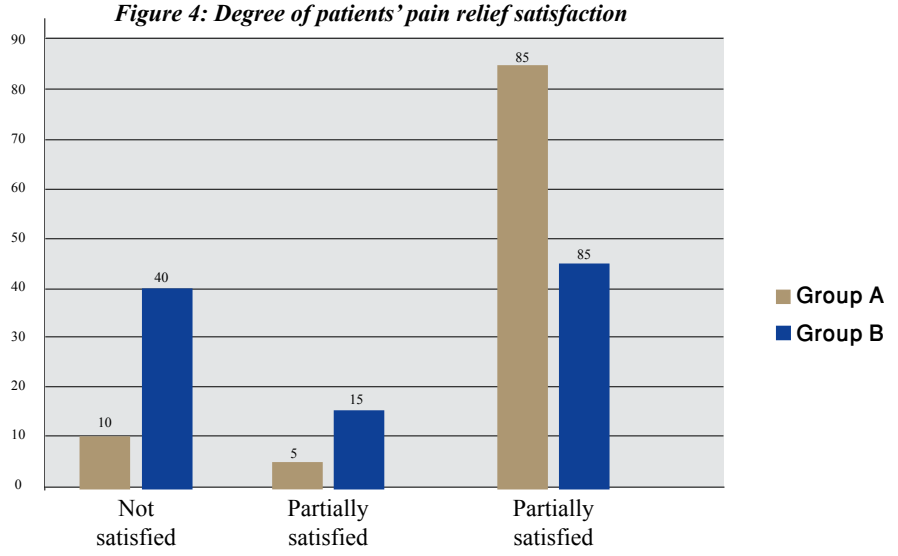
Figure 3: *Pain score distribution based on VAS in two study groups*



	VAS 0-3	VAS 4-6	VAS 7-10
Group A	19 (95%)	0	1 (5%)
Group B	3 (15%)	9 (45%)	8 (40%)

Figure 4: Degree of patients' pain relief satisfaction



	Not satisfied	Partially satisfied	Partially satisfied
Group A	2 (10%)	1 (5%)	17 (85%)
Group B	8 (40%)	3 (15%)	9 (45%)