Effects of parasternal block and local anaesthetic infiltration by levobupivacaine on postoperative pain and pulmonary functions after off-pump coronary artery bypass graft surgery

Pompasız koroner arter bypass greftleme cerrahisinden sonra levobupivakainle parasternal blok ve lokal anestezik infiltrasyonunun ameliyat sonrası ağrı ve akciğer fonksiyonları üzerine etkileri

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Background: In this study, the effects of levobupivacaine parasternal block and local anesthetic infiltration on postoperative pain and pulmonary functions after open heart surgery, were investigated.

Methods: This prospective, randomized, double-blinded study was performed between 1 February 2008 and 1 December 2008. A total of 20 ASA III-IV patients (12 males, 8 females; mean age 59.35; range 18 to 69 years) who underwent coronary artery bypass graft surgery, were included in either the Levobupivacaine group (Group LB, n=11) or Placebo group (Group P, n=9). Group LB patients received 0.25% levobupivacaine (1.35 mg/kg) locally infiltrated in both sides of the sternum in addition to routine procedures. The placebo group received no additional local anesthesia. Postoperative verbal rating skala (VRS) scores, morphine consumption and pulmonary functions were evaluated in all patients.

Results: Less complaints and lower VRS scores were observed in group LB compared to group P at different hours following extubation ($p<0.05$). Significantly lower 24-hour morphine consumption was found in group LB compared with group P ($p<0.001$). Significant decreases were recorded in pulmonary functions after surgery in both groups, however decreasing amounts of pulmonary function were not different between the two groups ($p>0.05$).

Conclusion: Parasternal block and local infiltration using levobupivacaine was effective for decreasing postoperative pain, however levobupivacaine was inefficient for prevention of pulmonary function deterioration following surgery. Further studies with more patients are needed to elucidate this topic.

Key words: Analgesia; bypass surgery; levobupivacaine; parasternal block; pulmonary functions.

Amaç: Bu çalışmada açık kalp ameliyatı sonrası levobupivakain parasternal blok ve lokal anestezik infiltrasyonunun ağrı ve solunum fonksiyonları üzerine olan etkileri araştırıldı.

Çalışma planı: Bu ileriye dönük, randomize ve çift kör çalışma, 1 Şubat 2008 ile 1 Aralık 2008 tarihleri arasında yapıldı. Koroner arter bypass greftleme ameliyatı uygulanan ASA III-IV grubu toplam 20 hasta, (12 erkek, 8 kadın; ort. yaş 59.35; dağılım 18-69 yıl) Levobupivakain grubu (Grup LB, n=11) veya Plasebo grubuna (Grup P, n=9) dahil edildi. Grup LB'ye, rutin uygulamaya ek olarak %0.25'lik levobupivakain (1.35 mg/kg) sternumun her iki tarafına lokal infiltrasyon şeklinde uygulandı. Plasebo grubuna ise ilave lokal anestezi yapılmadı. Tüm hastaların ameliyat sonrası sözel değerlendirme skalası (SDS) skoru, morfin tüketimi ve solunum fonksiyonları değerlendirildi.

Bulgular: Ekstübasyon sonrası farklı saatlerde bakılan SDS skorları ve yakınmalar grup LB'de, grup P'den anlamlı olarak düşük bulundu ($p<0.05$). Grup LB'de 24 saatlik morfin tüketimi de grup P'den anlamlı olarak düşük bulundu ($p<0.001$). Ameliyat sonrası solunum fonksiyon testlerinde her iki grupta da anlamlı düşüşler oldu ($p<0.010$), ancak solunum fonksiyonlarındaki bu düşüş miktarları iki grup arasında farklılık göstermiyordu ($p>0.05$).

Sonuç: Levobupivakain ile parasternal blok ve lokal infiltrasyon ameliyat sonrası oluşan ağrıyı azaltmada etkili, ancak ameliyatı takiben akciğer fonksiyonlarındaki bozulmayı önlemede yetersiz kaldı. Konunun daha iyi aydınlatılması için, daha fazla sayıda hasta içeren çalışmalara gereksinim vardır.

Anahtar sözcükler: Analjezi; bypass cerrahisi; levobupivakain; parasternal blok; solunum fonksiyonları.

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It has been reported that morbidity and mortality of open-heart-surgery increased due to cardiovascular, pulmonary, renal, neuropsychiatric and infectious complications. In order to decrease these complications, neuroendocrine stress responses to surgery should be blunted and recovery periods should be shortened.[1] Patients undergoing coronary artery bypass graft (CABG) surgery may have pain, immobilization, insufficient respiratory functions, inability to cough due to median sternotomy and chest tube entrance incisions; therefore duration of mechanical ventilation, intensive care unit (ICU) and hospital stay increase significantly. Thus, extubation should be speeded up with effective analgesic methods and drugs.[2-4] Postoperative analgesia might not be enough with low-dose opioids and volatile based anesthesia techniques. Intravenous (i.v) opioid treatment is often used for postoperative analgesia but high dose opioids may cause respiratory depression and sedation.[5-7]

Parasternal block and local anesthetic infiltration around the sternum may be useful in providing early postoperative analgesia even in anticoagulated patients. Regional anesthetic blocks are useful alternative methods in decreasing opioid needs and side effects such as respiratory depression and sedation. However their beneficial effects have rarely been reported.[5,6] Therefore, the aim of the present study was to investigate whether peroperative parasternal block with levobupivacaine had a favorable effect on postoperative pain and respiratory functions in patients undergoing off-pump coronary artery bypass graft (OPCABG) surgery.

PATIENTS AND METHODS

With Institutional Review Board approval and written informed consent obtained from all patients, this prospective, randomized and double-blinded study was performed between 1 February 2008 - 1 December 2008. Twenty patients (12 males, 8 females; mean age 59.35; range 18 to 69 years) with physical status III-IV according to the American Society of Anesthesiologists (ASA) were scheduled for elective OPCABG surgery. Exclusion criteria were known allergy to any of the study medications, coagulopathy, psychiatric problems, low ejection fractions (under 30%), severe heart failure, left ventricular aneurysm, myocardial infarction within the last six weeks, forced expiratory volume in 1st second (FEV_1) <50%, history of stroke or carotid artery disease; severe renal, pulmonary, liver, endocrine systemic disease, inability to operate a patient controlled analgesia (PCA) device.

During preoperative evaluation the day before surgery, information was given to patients about verbal rating skala (VRS), PCA and bedside spirometry device. We used a portable "Respiradyne II" (Manufacturer, Location (Sherwood Medical; St. Louis, MO) bedside spirometry device for measurement of FEV_1, FVC, FEV_1/FVC values. All patients were premedicated with midazolam, 0.05 mg/kg intramuscular (i.m), 45 min before the surgical procedure. In the operation room before induction and during surgery, all parameters including heart rate, ST-segment analysis and blood pressure were recorded using Datex Ohmeda S/5 (manufacturer, location (Datex-Ohmeda Division, Instrumentarium Corp., Helsinki, Finland) monitor.

Anesthesia was induced with etomidate (0.3 mg/kg i.v), fentanyl (2 μg/kg i.v) and rocuronium (0.9 mg/kg i.v), and was initially maintained with desflurane 5-8% inspired in combination with oxygen 50% in air.

The patients were randomly allocated into two groups according to computer-generated randomization. At the end of the surgery, before sternal closure, administration of 0.25% levobupivacain, 1.35 mg/kg, 50 ml (bilateral 5 costal levels and every level 2 ml, on both sides of the sternum over periosteum 20 ml and at the entrance of chest tubes, deep infiltration 10 ml) was performed in group LB (levobupivacain) patients. Group P (Placebo) patients received a total 50 ml saline (bilateral 5 costal levels and every level 2 ml, on both sides of the sternum over periosteum 20 ml and at the entrance of chest tubes, deep infiltration 10 ml).[5] All the staff in the operating room was unaware of the randomization and drugs were prepared by an investigator who was also blinded.

At the end of surgery, all anesthetics were discontinued and patients were transferred to the ICU where they were commited to a mechanical ventilator. In ICU, electrocardiography (ECG), peripheral oxygen saturation, invasive arterial pressure and central venous pressure were monitored.

During follow-up in ICU patients who had the following characteristics were extubated and extubation times were recorded;

1- Being fully conscious, obeying verbal commands,

2- Systolic arterial pressure ≥90 mmHg and stable cardiac rhythm,

3- No active bleeding,

4- VRS score ≤5,

5- SpO_2 ≥95 when 50% air-oxygene,

6- Respiratory rate 10-30/minutes,

7- Arterial pH ≥7.25, PCO_2 ≤55 mm/Hg.

Table 1. Demographic characteristics of the patients (Mean±SD)

	Levobupivacain group		Placebo group		*p*
	(n=11)	Mean.±SD	(n=9)	Mean±SD	
Age (year)		61.6±7.8		57.1±6.7	NS
Body mass index (kg/m^2)		26.8±3.9		26.9±4.2	NS
Sex					
Female	4		4		
Male	7		5		NS
Diabetes mellitus					
Yes	3		1		
No	8		8		NS
Cigarette					
Yes	3		3		
No	8		6		NS
Dysrythmia					
Yes	2		3		
No	9		6		NS

SD: Standard deviation; NS: Not significant.

Duration between ICU admission and extubation moment was accepted as "extubation time".

All the patients included in our study received morphine sulphate infusion with intravenous-PCA device (Abbott APM) for postoperative analgesia after extubation. Patient controlled analgesia device was set to deliver 2 mg/i.v bolus injections of morphine at a lock-out interval of 15 min and with a maximum four hours limit of 24 mg. The incremental bolus dose of morphine was increased to 3 mg if analgesia was inadequate (VRS pain score >5) after the first hour of PCA use. During postoperative 24 hour follow up; we recorded resting VRS scores and morphine consumption at 1st, 2nd, 3rd, 4th, 8th, and 24th hours. We also recorded FEV1, FVC, FEV1/FVC values measured by portable spirometry device at 6th, 12th, and 24th hours after extubation. All data were collected by an investigator who was also blinded.

Statistical analysis

Initial sample size estimation showed that approximately 17 patients were needed in each group to detect reduction of morphine consumption by 25% with a power of 0.80 and a level of significance of 5%. We used SPSS 13.0 version (SPSS Inc., Chicago, Illinois, USA) program for statistical analysis. Demographic data were evaluated by "descriptive statistical methods". Peri- and postoperative vital signs and VRS pain scores were compared by "Mann-Whitney U-test". Twenty-four-hour total morphine consumption in two groups was compared using "repeated measures variance analysis". Bedside pulmonary function tests were analyzed both within-groups and inter-groups using by "two-way variance analysis". Results were assessed at 95% confidence interval. A *p* value of less than 0.05 was accepted as statistically significant.

RESULTS

Twenty-two consenting patients who fulfilled the entry criteria were enrolled in this study. Two patients were excluded from the study in group P. One because of the need for use of intraaortic balloon pump after surgery and the other because of using perfusion pump during surgery. There was no significant difference in demographic data between the LB and P groups (p>0.05; Table 1). The distribution of mean VRS scores after extubation and at particular time intervals are seen comparatively in figure 1. All VRS values were statistically lower in group LB than group P (p<0.05).

Distribution of 24-hour-morphine consumption in groups LB and P are seen in table 2. At all measurement time intervals, morphine consumptions were statistically lower in group LB than group P (p<0.001).

When pulmonary functions were evaluated, significant decreases were found in FEV1 and FVC at 6th, 12th and 24th hours compared with preoperative

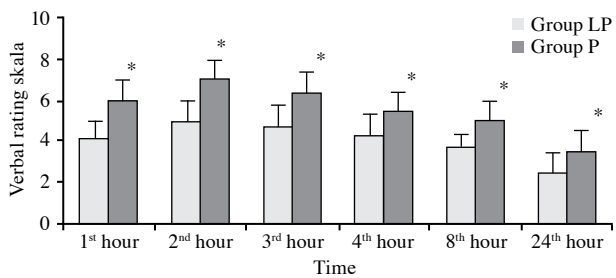

Fig. 1. Mean verbal rating skala scores. LB: Levobupivacain; P: Placebo; *: p<0.05.

Table 2. The comparison of morphin consumption (mg) between two groups (Mean±SD)

Time	Levobupivacain group (n=11)	Plasebo group (n=9)	*p
1st hour	3.4±0.3	5.8±0.3	<0.001
2nd hour	6.5±0.3	10.6±0.3	<0.001
3rd hour	10.3±0.3	15.5±0.3	<0.001
4th hour	13.3±0.3	21.2±0.3	<0.001
8th hour	19.0±0.3	31.3±0.3	<0.001
24th hour	32.8±0.3	45.4±0.3	<0.001

*: With repeated measures analysis of variance; SD: Standart deviation.

"first measurements" in both LB and P groups. The decreased FEV1 and FVC values as liters (L) and percentage (%) is shown in table 3. There were no significant differences in decreases of FEV1 and FVC between the two groups (p>0.05).

Mean intubation time and mean extubation times were statistically shorter in group LB than group P (288±18 minutes vs. 359±44 minutes respectively, p<0.001; 119±20 minutes vs. 198±10 minutes, respectively, p<0.001).

DISCUSSION

In this study, the parasternal block technique with levobupivacain decreased postoperative severity of pain, morphine consumption and extubation time without leading to further insufficiency in pulmonary functions.

Elective CABG may lead to pain due to median sternotomy and chest tube entrance incisions. These patients may also suffer from immobility, insufficient ventilation and inability to cough. Therefore, their weaning from mechanical ventilation may be delayed and the duration of stay in the ICU and hospital may be lengthened. For these reasons, accelerating extubation with effective analgesic methods and drugs will be the main target.[8]

For OPCABG surgery patients; i.v opioids, intrathecal morphine and epidural analgesia are used as classical analgesic methods. However, most anesthetists avoid epidural methods because of potential hematoma development risk.[5] Intravenous opioid therapy is often used for postoperative analgesia. Although intravenous opioids are very effective, their use is being restricted due to respiratory depression.[9]

Levobupivacaine; is a long acting, less cardiotoxic local anesthetic with less central nervous system (CNS) side effects. The dose used for parasternal block and local infiltration is 1.35 mg/kg which is under the toxic dose (277±51 mg).[10,11] Infiltration of surgical wounds has been reported to enhance postoperative analgesia after various procedures such as upper abdominal surgery,[12] open cholecystectomy,[13] abdominal hysterectomy,[14] caesarean section[15] and inguinal herniotomy.[16] Ng et al.[17] performed local infiltration of levobupivacaine + ephedrine in laparoscopic cholesystectomy, intraperitoneally and around the incision site; the levobupivacaine group had significantly lower VRS scores than the placebo group. Morphine consumption was also lower than placebo. Another study performed in laparoscopic gynecologic surgery reported that preoperative local levobupivacaine infiltration significantly decreased postoperative wound pain, average VRS scores and analgesic consumption.[18] Papagiannopoulou et al.[19] performed local infiltration of levobupivacaine and ropivacaine before incision in laparoscopic cholesystectomy; the levobupivacaine group had significantly lower VRS scores and morphine consumption. In our study, the parasternal block was performed by local levobupivacaine infiltration at the end of surgery; this method is also easy, simple and safe like local anesthetic infiltration before surgery.

Other than parasternal block and local infiltration with levobupivacaine after surgery, the effectiveness of intercostal block and thoracic epidural analgesia have

Table 3. Changes of pulmonary function tests between groups

	FEV1		FVC	
Variables	Group LB	Group P	Group LB	Group P
In liter change				
Preoperative first value	2.6±0.5	2.0±0.5	3.3±0.7	2.8±0.6
Postoperative values				
6th hour	1.0±0.4	1.0±0.5	1.6±0.7	1.3±0.8
12th hour	1.1±0.4	0.9±0.7	1.4±0.7	1.2±0.8
24th hour	1.2±0.4	0.7±0.8	1.5±0.6	1.0±0.6
Percent change				
6th hour	62.4±7.8	52.5±22.5	52.9±15.8	53.2±24.8
12th hour	58.3±16.6	54.0±18.8	58.8±13.6	56.5±15.9
24th hour	53.7±15.9	62.9±16.6	53.8±15.7	63.8±10.2

FEV1: First second forced expiratory volume; FVC: Forced vital capacity; LB: Levobupivacain; P: Placebo; No statistical difference was found between groups.

also been investigated in thoracic surgery. Concha et al.[20] compared two groups usingintercostal block and thoracic epidural methods on posterolateral thoracotomy patients. They used 0.5% levobupivacaine as local anesthetic together with intravenous morphine. One day before operation, basal FEV1 and FVC values were measured. Postoperative 1st, 2nd, 3rd, 4th, 12th, and 24th hour dynamic and resting VRS scores were recorded. Postoperative FEV1 and FVC values were decreased 60% with respect to the basal values and inter-group differences of decrease were not statistically significant. In the study of McDonald et al.,[5] 24-hour-morphine consumption has been found significantly lower after parasternal block and local infiltration by levobupivacaine in patients undergoing cardiac surgery under desflurane anesthesia. Although parasternal block and local infiltration decreased the pain, pulmonary function tests (FEV1 and FVC) were still impaired. The decreased ratio of pulmonary function tests (FEV1 and FVC) were 50-55% according to preoperative "first measure" values, and these ratios were similar for both levobupivacaine and control groups.[5] In our OPCABG study, owing to the levobupivacaine parasternal block technique, extubation times were significantly shorter than the control group. Thereby lesser opioid need and less sedation were seen and ICU stay was also significantly shorter. However, according to our results, parasternal block and local infiltration of LB could not prevent impairment of pulmonary function tests, since significant decreases of pulmonary function tests were found in both groups FEV1 and FVC values were 55-60% lower than preoperative values after surgical operation. It is not enough to explain impaired FEV1 and FVC only with pain.[21] Other reasons of impaired pulmonary functions may be deterioration in chest wall integrity after sternotomy and irritation of free edges of chest drains on deep inspiration. Even if the patients are painless with morphine infusion, they might be afraid of taking deep breaths. These reasons are suggested to cause impaired spirometry values.[22] After operations like cardiac surgery, where the thorax is opened, FEV1 and FVC will inevitably decrease.

In conclusion, parasternal block and local anesthetic infiltration with levobupivacaine decreased postoperative pain and shortened extubation time in our study group. However, it could not prevent postoperative impairment of pulmonary function. In order to enlucidate this topic, further studies with larger study groups are needed.

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