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OPEN ARAŞTIRMA MAKALESİ / RESEARCH ARTICLE

Comparison of the Effects of Preoperative or Postoperative Parasternal Block in the First 24 Hours in Patients Who Had Cardiac Surgery with Sternotomy

Sternotomi ile Kalp Cerrahisi Yapılan Hastalarda, Parasternal Bloğun Preoperatif veya Postoperatif Yapılmasının ilk 24 Saatteki Etkilerinin Karşılaştırılması

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ÖZET

Amaç: Bizim amacımız median sternotomi ile kardiyak cerrahi geçiren hastalarda, parasternal bloğun operasyon başlamadan önce ve operasyon bittikten sonra uygulanmasının, postoperatif sternum ağrısı, opioid ihtiyacı, komplikasyon, ekstübasyon zamanı ve bloğun uygulama kolaylığı açısından karşılaştırılmasını yapmaktır.
Gereçler ve Yöntem: Çalışma tek merkezli, gözlemsel ve retrospektiftir. Çalışmaya preoperatif parasternal blok yapılan (N=20) ve postoperatif parasternal blok yapılan (n=20) 40 hasta dahil edildi. Tüm hastalar, intravenöz midazolam (0.05-0,1 mg/kg), fentanil (2-5 µ/kg IV), propofol (1-2 mg/kg), roküronyum (1 mg/kg) ile trakeal entübe edildi. Anestezi idamesi, sevofluran (MAC 1), O2/hava (FIO2 0,40), fentanil (2–5 µ/kg/h) ve roküronyum (0.2-0,4 mg/kg) ile sağlandı. Preoperatif gruptaki hastalara, cerrahi öncesi blok yapılmıştır. Diğer gruba ise cerrahi bittikten sonra blok yapılmıştır.
Bulgular: Preoperatif ve postoperatif dönemde aynı bloğun yapıldığı 40 hasta çalışmaya dahil edildi. Preoperatif parasternal blok yapılan ve postoperatif parasternal blok yapılan iki grup arasında yaş, cinsiyet, ek hastalık, ASA skorlaması ve operasyon süresi açısından anlamlı fark bulunmamıştır. Gruplardaki hastaların dosyaları yoğun bakım sürecinde ağrı, opioid ihtiyacı, ekstübasyon zamanı ve komplikasyon gelişimi açısından değerlendirilmiştir.
Sonuç: Sonuç olarak parasternal bloğun cerrahi öncesi veya cerrahi bitiminde yapılmasının sternum ağrısının başlama zamanı, opioid ihtiyacı, komplikasyon oluşumu ve ekstübasyon zamanı üzerinde anlamlı bir etkisi yoktur. Fakat bloğun preoperatif veya postoperatif yapılması bloğun yapılma süresi üzerine etkilidir.

Anahtar Kelimeler: Parasternal blok, kardiyak cerrahi, sternum ağrısı

ABSTRACT

Aim: Our aim is to compare the application of parasternal block before and after the operation in terms of postoperative sternum pain, opioid need, complications, extubation time and ease of application of the block in patients undergoing cardiac surgery with median sternotomy.
Materials and Methods: The study is single-center, observational and retrospective. 40 patients who underwent preoperative parasternal block (N=20) and postoperative parasternal block (n=20) were included in the study. All patients were tracheally intubated with intravenous midazolam (0.05-0.1 mg/kg), fentanyl (2-5 µ/kg IV), propofol (1-2 mg/kg), rocuronium (1 mg/kg). Anesthesia maintenance was provided with sevoflurane (MAC 1), O2/air (FIO2 0.40), fentanyl (2–5 µ/kg/h) and rocuronium (0.2–0.4 mg/kg). Patients in the preoperative group received a block before surgery. The other group received a block after the surgery was completed.
Results: 40 patients who underwent the same block in the preoperative and postoperative periods were included in the study. There was no significant difference between the two groups in which preoperative parasternal block and postoperative parasternal block were performed in terms of age, gender, comorbidities, ASA scoring and operation time. The files of the patients in the groups were evaluated in terms of pain, opioid need, extubation time and development of complications during the intensive care unit process..
Conclusion: As a result, performing parasternal block before or at the end of surgery does not have a significant effect on the time of onset of sternum pain, opioid need, occurrence of complications and extubation time. However, whether the block is performed preoperatively or postoperatively has an effect on the duration of the block.

Keywords: Parasternal block, cardiac surgery, sternum pain

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INTRODUCTION

Developments in cardiac surgery have been closely followed in Turkey, and the first successful open-heart surgery was performed at Hacettepe University in 1960 (1). Pain that is not adequately controlled after heart surgery can lead to serious problems such as delayed healing and prolonged hospital stays (2). Inadequate pain control following sternotomy procedures can result in a high incidence of post-sternotomy persistent pain syndrome (3). Regional anesthesia techniques such as epidural anesthesia or paravertebral blocks are generally not suitable during cardiovascular surgery due to systemic reasons such as heparinization (2).

In cardiac surgery, the use of opioids is traditionally common for both intraoperative and postoperative pain control (4). Opioid-based analgesia has side effects such as nausea, vomiting, sedation, urinary retention, respiratory depression, constipation, and delayed extubation (3).

Recently, several chest wall blocks have been described and investigated for various thoracic surgeries, including heart surgeries (5). All these blocks contribute to better control of chest pain in cardiac surgery, faster recovery, and shorter discharge times(6). In patients who have undergone median sternotomy, parasternal blocks (PSBs), which can be considered relatively new, are effective alternatives for analgesia in postoperative pain management (7-9). PSBs can be administered as superficial parasternal intercostal plane (PIP) blocks and deep PIP blocks (10). Superficial PSBs are performed by injecting a local anesthetic between the pectoralis major and superficial intercostal muscles (11). This blocks the anterior cutaneous branches of the thoracic intercostal nerves (12). Since the nerve supply to the sternal area extends from thoracic 2 (T2) to T6, this block provides adequate analgesia for the sternotomy area(13).

This study aimed to compare the application of superficial PSBs before and after the operation in patients undergoing cardiac surgery with median sternotomy in terms of postoperative sternum pain, opioid requirement, complications, extubation time, and ease of block application.

MATERIALS AND METHODS

This single-center, observational, and retrospective study was approved by the Clinical Research Ethics Committee of Ordu University (Decision No: 2023/351). A total of 40 patients who underwent preoperative (n = 20) or postoperative (n = 20) PSB were included in the study. The preoperative PSB was performed while the patient was in the supine position after the induction of general anesthesia and before the start of the surgery, while the postoperative PSB was administered immediately before the patient was transferred to the intensive care unit after the surgery was completed.

Inclusion and exclusion criteria

All cardiac surgery patients who underwent median sternotomy, including heart valve replacement, coronary artery bypass graft surgeries, and aortic aneurysm surgery, in the cardiovascular surgery operating room of our hospital between September 1, 2023 and December 15, 2023 were included in the study.

Patients under 18 years of age, pregnant or breastfeeding women, those with known allergies to local anesthetics, emergency or revision cases, patients with mental retardation or those who could not communicate effectively, and surgical cases that did not involve sternotomy were excluded from the study.

Anesthesia management

In all patients, perioperative management was conducted in accordance with the standard care protocols for cardiac anesthesia at our center. Before the induction of general anesthesia, electrocardiogram, non-invasive arterial blood pressure, and arterial blood oxygen saturation were monitored through pulse oximetry. After monitoring, all patients were tracheally intubated with intravenous midazolam (0.05–0.1 mg/kg), fentanyl (2–5 µ/kg IV), propofol (1–2 mg/kg), and rocuronium (1 mg/kg). Anesthesia maintenance was provided with sevoflurane (minimal alveolar concentration 1), O2/air (FiO2 0.40), fentanyl (2–5 µ/kg/h), and rocuronium (0.2–0.4 mg/kg). In sedated patients, invasive arterial catheterization (radial or femoral) and central venous catheterization (jugular, subclavian, or femoral) were performed. At the end of the operation, patients were transferred to the intensive care unit while intubated without administering additional analgesic agents.

Preoperative PSB under ultrasound guidance

After the patients were tracheally intubated, the T3–T6 region and the ultrasound probe were prepared under aseptic conditions while the patients were in the supine position before the surgery commenced. The linear transducer was placed longitudinally on the sternum at the level of T4 and shifted approximately 2–3 cm laterally from the midline (Figure 1). A 21-gage 50 mm block needle was advanced cephalad from the caudal direction using the in-plane technique, and when it reached the space between the pectoralis major and

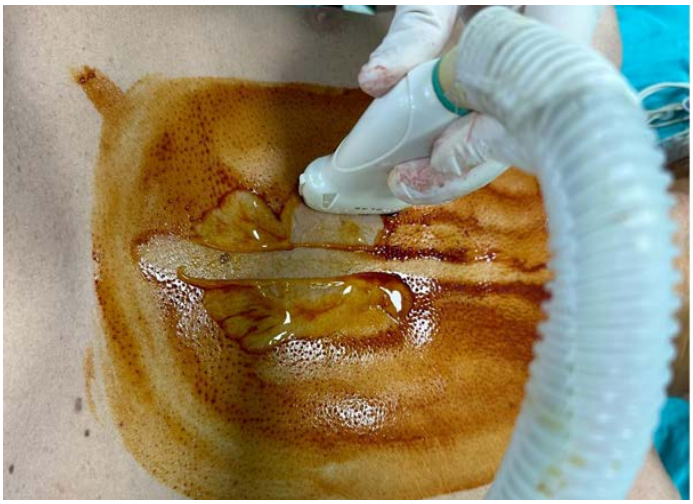

Figure 1. Parasternal block application

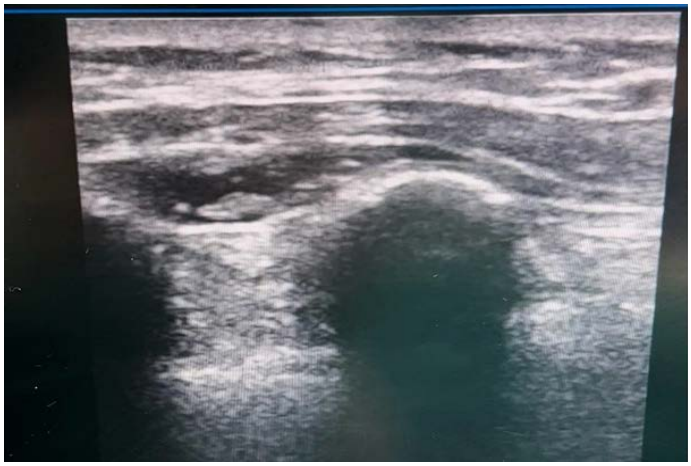

Figure 2. Spread of local anesthetics between the pectoralis major muscle and the superficial intercostal muscle

intercostal muscles, confirmation was made with physiological saline. After observing a zipper-like separation on ultrasound, aspiration was performed to confirm no blood was present. Subsequently, a total of 15 cc of local anesthetic was injected, consisting of 10 cc of bupivacaine (%5) and 5 cc of lidocaine (%2) (Figure 2). The same procedure was performed on the opposite side. The patient was then handed over to the surgical team.

Postoperative PSB under ultrasound guidance

After the operation was completed and the skin was sutured, the ultrasound probe was prepared under aseptic conditions without compromising the existing sterility, and the procedure was initiated. The linear transducer was placed longitudinally on the sternum at the level of T4 and shifted approximately 2–3 cm laterally from the midline. A 21-gage 50 mm block needle was advanced cephalad from the caudal direction using the in-plane technique, and when it reached the space between the pectoralis major and external intercostal muscles, confirmation was made with physiological saline. After observing a zipper-like separation on ultrasound, aspiration was performed to confirm no blood was present. Subsequently, a total of 15 cc of local anesthetic was injected, consisting of 10 cc of bupivacaine (%5) and 5 cc of lidocaine (%2). The same procedure was performed on the opposite side. The patient was then transferred to the intensive care unit while intubated and being monitored.

Intensive care process

At the end of the operation, patients were transferred to the intensive care unit while intubated and under monitoring for follow-up. Before beginning communication with the patients, analgesic agents were not administered unless there was an increase of more than 15%–20% in blood pressure and pulse values compared to the preoperative baseline values. After communication was established, the presence or absence of pain was assessed, and if pain was present, its localization was evaluated. Patients reporting pain in the sternum area were initially administered intravenous non-steroidal anti-inflammatory drugs (NSAIDs). Subsequently, intravenous opioids were administered to those patients who continued to experience pain after being re-evaluated. During the intensive care process in the first 24 hours postoperatively, records were also reviewed regarding the patients' extubation times, as well as any complications related to the local anesthetic and the block, in addition to pain and opioid requirements.

Statistical analysis

The data were analyzed using the IBM SPSS Statistics Standard Concurrent User V 26 (IBM Corp., Armonk, New York, USA) statistical software package. Descriptive statistics were presented as a number, percentage, mean, standard deviation, median, minimum, and maximum values. The normal distribution of numerical variables was evaluated using the Shapiro–Wilk normality test. Numerical variables were found to be normally distributed. Independent samples t-test was used to compare the numerical descriptive characteristics of the patients between groups, and chi-square tests (Pearson chi-square/Fisher exact test) were used to compare the categorical descriptive characteristics between groups. The chi-square goodness of fit test was used to compare the variables across the follow-up times within the groups. A p-value of <0.05 was considered statistically significant in all analyses.

RESULTS

Table 1 shows the distribution of the descriptive characteristics of the participants between the groups. A total of 40 people were included in the study: 20 in the preoperative group and 20 in the postoperative group. The median age of the participants was 65 years in the preoperative group and 67 years in the postoperative group. The median operation time was 172 minutes in the preoperative group and 174 minutes in the postoperative group. There were 14 (70%) male patients in the preoperative group and 15 (75%) in the postoperative group. There were 4 (20%) American Society of Anesthesiologists III patients in the preoperative group and 5 (25%) in the postoperative group. Seven (35%) patients in the preoperative group and eight (40%) patients in the postoperative group had an extubation time of 6 hours. The descriptive characteristics of the participants in the parasternal groups had a similar (homogeneous) distribution ($p > 0.05$). The duration of the block was between 3 and 5 minutes in the preoperative group and between 5 and 7 minutes in the postoperative group ($p < 0.05$).

Table 2 presents the comparison of sternum pain, opioid usage, complications, and extubation status across the follow-up times between the groups. At five different measurement times, the number of patients with sternum pain was statistically similar between the groups ($p > 0.05$). In the preoperative group, there were 0 participants (0%) with sternum pain at the 4th hour, 2 participants (10%) at the 6th hour, 1 participant (5%) at the 10th hour, 1 participant (5%) at the 15th hour, and

Table 1. Comparison of descriptive characteristics of the participants between the groups (n = 40).

	Parasternal		p-value
	Preoperative n = 20	**Postoperative n = 20**	
Age,(years)			
X ± SD	64,20 ± 7,09	68,35 ± 9,96	0,137 †
M(min–max)	65 (51-78)	67 (57-59)	
Operation time, (minutes)			
X ± SD	172,00 ± 22,38	176,25 ± 20,70	0,537 †
M(min–max)	170 (135-220)	174 (140-220)	
Sex			
Male	14 (%70)	15 (%75)	0,500 ϕ
Female	6 (%30)	5 (%25)	
Comorbidity			
No	3 (%15)	5 (%25)	0,347 ϕ
Yes	17 (%85)	15 (%75)	
ASA			
ASA III	4 (%20)	5 (%25)	0,500 ϕ
ASA IV	16 (%80)	15 (%75)	
Extubation time			
6th hour	7 (%35)	8 (%40)	0,500 ϕ
10th hour	13 (%65)	12 (%60)	
Block time			
3–5 minutes	20 (%100)	0 (%0)	0,000 ϕ
5–7 minutes	0 (%0)	20 (%100)	

Independent samples t-test(†); chi-square test (ϕ); American Society of Anesthesiologists (ASA). Descriptive statistics are presented as mean (X), standard deviation (SD), median (M), minimum (min), maximum (max), number (n), and percentage (%). Bold sections show statistically significant results ($p < 0.05$).

Table 2. Comparison of sternum pain, opioid use, complications, and extubation status between groups during follow-up (n = 40).

	Parasternal		p †
	Preoperative n = 20	**Postoperative n = 20**	
Sternum pain			
4th hour	0 (%0)	0 (%0)	0,999
6th hour	2 (%10)	2 (%10)	0,999
10th hour	1 (%5)	2 (%10)	0,564
15th hour	1 (%5)	2 (%10)	0,564
24th hour	1 (%5)	0 (%0)	0,999
p ϕ	0,896	0,999	
Opioid use			
4th hour	2 (%10)	1 (%5)	0,564
6th hour	1 (%5)	3 (%15)	0,317
10th hour	2 (%10)	3 (%15)	0,655
15th hour	1 (%5)	1 (%5)	0,999
24th hour	0 (%0)	0 (%0)	0,999
p ϕ	0,881	0,572	
Complication			
4th hour	0 (%0)	0 (%0)	0,999
6th hour	0 (%0)	0 (%0)	0,999
10th hour	0 (%0)	0 (%0)	0,999
15th hour	0 (%0)	0 (%0)	0,999
24th hour	0 (%0)	0 (%0)	0,999
p ϕ	0,999	0,999	
Extubation			
4th hour	0 (%0)	0 (%0)	0,999
6th hour	7 (%35)	8 (%40)	0,796
10th hour	20 (%100)	20 (%100)	0,999
15th hour	20 (%100)	20 (%100)	0,999
24th hour	20 (%100)	20 (%100)	0,999
p ϕ	0,036	0,046	

Chi-square test for goodness of fit ($\chi 2$); ϕ Intra-group comparison; † Inter-group comparison. Descriptive statistics are presented as number (n) and percentage (%). Bold sections show statistically significant results ($p < 0.05$).

1 participant (5%) at the 24th hour. The number of participants with sternum pain in the preoperative group did not show a statistically significant change over time ($p > 0.05$). In the postoperative group, there were 0 participants (0%) with sternum pain at the 4th hour, 2 participants (10%) at the 6th hour, 2 participants (10%) at the 10th hour, 2 participants (10%) at the 15th hour, and 0 participants (0%) at the 24th hour. The number of participants with sternum pain in the postoperative group did not show a statistically significant change over time ($p > 0.05$).

At five different measurement times, the number of participants with opioid use was statistically similar between the groups ($p > 0.05$). In the preoperative group, there were 2 participants (10%) using opioids at the 4th hour, 1 participant (5%) at the 6th hour, 2 participants (10%) at the 10th hour, 1 participant (5%) at the 15th hour, and 0 participants (0%) at the 24th hour. The number of participants with opioid use in the preoperative group did not show a statistically significant change over time ($p > 0.05$). In the postoperative group, there was 1 participant (5%) using opioids at the 4th hour, 3 participants (15%) at the 6th hour, 3 participants (15%) at the 10th hour, 1 participant (5%) at the 15th hour, and 0 participants (0%) at the 24th hour. The number of participants with opioid use in the postoperative group did not show a statistically significant change over time ($p > 0.05$). No complications were observed in participants from both groups at all follow-up times. No statistically significant differences were found within and between groups in terms of complications ($p > 0.05$).

At five different measurement times, the number of participants extubated was statistically similar between the groups ($p > 0.05$). In the preoperative group, there were 0 participants (0%) extubated at the 4th hour, 7 participants (35%) at the 6th hour, 20 participants (100%) at the 10th hour, 20 participants (100%) at the 15th hour, and 20 participants (100%) at the 24th hour. In the preoperative group, all patients were extubated by the 10th hour. In the postoperative group, there were 0 participants (0%) extubated at the 4th hour, 8 participants (40%) at the 6th hour, 20 participants (100%) at the 10th hour, 20 participants (100%) at the 15th hour, and 20 participants (100%) at the 24th hour. In the postoperative group, all patients were extubated by the 10th hour.

DISCUSSION

In this study, patients who underwent cardiac surgery with median sternotomy were compared regarding postoperative pain management, opioid requirements, complications, extubation times, and the durations of block application, with the same trunk block being administered preoperatively and postoperatively. A significant difference was observed between the two groups only in terms of the duration of block application.

With the increase in life expectancy, the average age of patients undergoing heart surgery has also risen. Therefore, as age increases and comorbidities rise, the patient profile becomes a higher-risk population. In this group of elderly patients with multiple comorbidities, anesthetic management is of even greater importance for maintaining stable vital signs (14).

The mean age of the patients in the present study was above 65, representing a high-risk patient group with multiple comorbidities. Various regional anesthetic techniques are recommended for better control of sternal pain after cardiac surgery. Starting from neuroaxial techniques, various approaches targeting the thoracic fascial plane, which contains intercostal nerves from T1 to T11, have been developed, including pectoral, serratus anterior, parasternal, and erector spinae plane blocks (15, 16). According to recent studies by Sepolvere et al., the PSB is noted as one of the more promising fascial blocks for the control of sternal pain compared to other trunk blocks (17, 18).

In the present study, a decrease in pain complaints and opioid requirements was observed within the first 24 hours in patients who received the PSB, while the timing of the block, whether preoperative or postoperative, did not affect the onset time of pain. In the preoperative parasternal group, the average duration of the block procedure was 3–5 minutes, whereas in the postoperative parasternal group, this duration was 5–7 minutes. In other words, performing the block during the preoperative period, without compromising tissue integrity, provides the practitioner with ease of visualization and shortens the duration of the block procedure. Moreover, the results of the chi-square test indicate a statistically significant difference between the groups regarding the duration of the block procedure ($p < 0.05$).

It was observed that patients who received the PSB were extubated and transferred from the intensive care unit to the ward earlier compared to patients who did not receive the block (14). In the present study, it was observed that although there was no significant difference in extubation times between the two groups that received the block, extubation occurred earlier in patients who did not receive an effective block and experienced pain.

In patients undergoing cardiac surgery with median sternotomy, ultrasound-guided PSB is an effective, safe, and technically easy method to apply (14). The PSB performed in our clinic by the same physician was completed quickly and without complications. However, in a patient who underwent preoperative PSB, hemorrhage was observed between the intercostal muscles after sternotomy. The timing of the PSB, whether preoperative or postoperative, resulted in a statistically significant difference in the duration of the block procedure. Performing the block in the preoperative period, without compromising the anatomical integrity of the tissue, allows for clearer and easier visualization of muscle structures on ultrasound. This makes the block easier to perform.

Many clinical studies have shown that PSB provides effective intraoperative analgesia in cardiac surgery and reduces opioid consumption (19, 20). In patients undergoing cardiac surgery with median sternotomy, ultrasound-guided PSB is easy to perform, safe, and effective. The PSB, which is effective in reducing intraoperative opioid consumption and achieving pain control, has a lower efficacy on postoperative

analgesia (14).

In the present study, the postoperative opioid requirement for patients who underwent the PSB due to sternum pain was very low (out of 40 patients, only 14 received opioids, with 10 of them requiring opioids for pain at the drainage site). NSAIDs were sufficient for patients experiencing sternum pain (out of 11 patients with sternum pain, only 4 required opioid treatment). There was no statistically significant difference between the groups.

This study investigated the effect of preoperative and postoperative PSB on analgesic requirements in patients undergoing cardiac surgery via median sternotomy. Important results have been obtained; however, the study has some limitations. These limitations include the study being single-centered and all blocks being performed by the same participant. Future studies could be planned as multicenter trials with blocks performed by different physicians.

CONCLUSION

In conclusion, performing the PSB either before surgery or at the end of the procedure does not have a significant effect on the onset of sternum pain, opioid requirement, complication occurrence, or extubation time. However, performing the block preoperatively enhances visualization for the practitioner due to preserved tissue integrity, facilitating the procedure. In clinical practice, if a block is planned for postoperative analgesia in patients undergoing sternotomy, performing the procedure before the surgery while tissue integrity is still preserved will facilitate an easier and faster execution of the application.

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