Eur J Transl Myol 32 (4): 10836, 2022 doi: 10.4081/ejtm.2022.10836

Analgesic effect of ketorolac added to lidocaine in surgery of traumatic arm injuries: A double-blind, randomized clinical trial

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Abstract

This randomized and double-blind clinical trial aimed to compare the analgesic effect of intravenous injection of ketorolac when lidocaine is added to Bier's block in surgery of traumatic upper limb injuries. The selected patients were randomly assigned to three study groups. The intensity of pain, the amount of morphine consumed through an intravenous patient controlled analgesia (PCA) pump, the incidence of morphine and ketorolac side effects and the patient's overall satisfaction were compared between groups. The three groups studied were similar and did not statistically differed in terms of quantitative and qualitative demographic variables. The median tourniquet closing time was different between the control group and the intravenous ketorolac and topical ketorolac groups with p=0.002 and p=0.001, respectively. There was no significant difference between the three groups in terms of time of the first request to receive painkillers after deflating the tourniquet, but the amount of morphine received between the groups was significantly different (p=0.02). Comparison of pain intensity based on numerical rating scale (NRS), considering the repetition times of the measurement, showed a significant difference in pain intensity between groups (p = 0.001) Overall satisfaction with the quality of analgesia and method of anesthesia did not differ significantly between the three study groups.. The groups receiving ketorolac did not presented of drug-related complications. In summary, ketorolac reduces the intensity of postoperative pain both during the time spent in the recovery room and during the transfer to the hospital ward, thus reducing the overall amount of morphine received by patients.

Key words: Ketorolac; Bier block; lidocaine; surgery for traumatic injuries of the upper limb.

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Pain is one of the important and preventable side effects of surgery. Indeed pain is not adequately controlled in half of the surgeries.[1] Even a short pain is associated with decrease in the feeling of health and decreases physical and social performance.[2] Pain after surgery not only affects the results of the operation and the patient's satisfaction from the operation, but may causes tachycardia, increased breathing rate, decreased alveolus breathing, weakened wound healing and insomnia.[3,4] Also, hypoxemia, atelectasis, pneumonia, deep vein thrombosis, pulmonary embolism, psychological trauma, delay in recovery of bowel function, ischemia and heart attack, urinary retention and delirium are among the complications of inadequate pain control after surgery.[5,6] Since acute postoperative pain can be associated with many injuries if not controlled, the anesthetist is responsible for monitoring and treating it even after the operation. With the progress of knowledge, different local techniques have been created to control postoperative pain, including the use of intravenous pain pumps, systemic methods such as opioids and local epidural methods. One of the effective methods used in post-operative pain control is drug administration before surgical incision, which is called pre-operative analgesia.[7]

Many studies have suggested the preventive treatment of pain after surgery as a method to reduce the time of the first request for narcotics, reduce the length of hospitalization, improve the patient's condition and increase the patient's satisfaction.[8,9] Local anesthesia is a simple, reliable, and a cost-effective anesthetic technique that is ideal for treating minor surgeries of the extremity,[10] eventually through intravenous injection of

a local anesthetic with blocking blood circulation by a tourniquet,[10] a method that is widely used in hand and arm surgery.[11]

Many studies have been conducted to find a compound local anesthesia that can increase the period of anesthesia after opening the tourniquet,[12] and many auxiliary drugs such as narcotics and non-narcotics that reduce pain after surgery and improve the quality of anesthesia have been tested. Intravenous local anesthetic is added to a (local) anesthetic such as lidocaine. Among the non-narcotic drugs used in pain control, drugs such as non-steroidal anti-inflammatory drugs (such as ketorolac) and acetaminophen constitute the majority of drugs used. Ketorolac is an injectable non-steroidal anti-inflammatory drug that has analgesic properties and is effective in the short-term control of moderate to severe postoperative pain.[7]

Therefore, the aim of this study is to compare the analgesia effect of ketorolac in intravenous injection and when it is added to lidocaine in Bier block in the surgery of traumatic injuries of the upper limb.

Materials and Methods

The project was carried out after being approved by the Research Council of the Faculty of Medicine and receiving the code of ethics with the number IR.SUMS.MED.RED.1394.19 and receiving the introduction letter and IRCT code is IRCT2015031419470N20.This study was a clinical trial, randomized and double blind. The target population was patients who were candidates for upper limb orthopedic surgery in Shahid Chamran Hospital, Shiraz-Iran, and patients who met the inclusion criteria were included in the study.

Inclusion criteria: All patients who undergo orthopedic surgery due to traumatic injuries of the upper limb and are eligible to receive Bier block based on the anesthesiologist's diagnosis, age range 20-60 years, ASA class I-II, duration of operation less than 90 minutes, having the mental ability to answer the questions and having provided informed consent.

Exclusion criteria: Long-term use of painkillers, depression, uncontrolled seizures, peripheral nerve diseases, kidney failure, sensitivity to the studied drugs, the presence of vascular problems and infection, the presence of signs of nerve damage in the person's body, liver failure and Glucose-6-Phosphate Dehydrogenase deficiency.

Considering the smallest difference in average pain intensity based on the existing numerical pain scale between the groups (mean 0.7 and standard deviation 0.75 in one group and mean 0.28 and standard deviation 0.37 in the other group) and considering the first type error of 5% and the power is 80%, the minimum sample size required to conduct this study is 96 people, which was calculated as 32 people in three groups.

Randomly selected patients were placed in one of 3 study groups (distilled water, intravenous ketorolac, and topical ketorolac). After each patient enters the operating room and demographic information is registers (such as age, sex, weight, type of lesion, and surgery) in the data collection form, then the basic monitoring tools, including a pulse oximeter, electrocardiography, and non-invasive measurement tools for blood pressure was connected to the patient and the existence of a cannulated vein in the healthy hand was ensured for the injection of fluids and medicine.

Then, the blood drainage direction was kept up for 10 minutes (with an angle of 90 degrees). After that, the lower cuff was inflated for a short moment with a pressure of 250 mm Hg, and immediately after that, the upper cuff was inflated with the same pressure, and the lower cuff was deflated. After making sure that there is no arterial pulse in this hand with the help of a pulse oximeter, drugs were prescribed:

1. Distilled water group: 3 mg/kg of 2% lidocaine plus 1 microgram/kg of fentanyl, which was diluted with distilled water to the extent that the concentration of lidocaine reaches 0.5% as a Bier block injection solution (in a 50 mL syringe) with 5 ml of distilled water which was injected intravenously and systemically from the opposite hand.
2. Topical ketorolac group: 3 mg/kg of 2% lidocaine plus 1 microgram/kg of fentanyl and 30 mg of ketorolac (30 mg/1 mL ampoule (Ketorolac-Exir, Exir Pharmaceutical Co., Iran) Distilled water, its final volume was increased until the concentration of lidocaine reached 0.5% as a Bier block injection solution (in a 50 mL syringe) along with 5 ml of distilled water which was injected intravenously and systemically from the opposite hand.
3. Intravenous ketorolac group: 3 mg/kg lidocaine 2% plus 1 microgram/kg fentanyl diluted with distilled water to the point where the concentration of lidocaine reaches 0.5% as Bier block injection solution (in a 50 mL syringe) with With 30 mg of ketorolac, the volume of which has been increased to 5 mL with distilled water, and it was injected intravenously and systemically from the opposite hand.

Then, in each group, Beer solution was slowly injected into the affected hand and the then systemic intravenous solution was injected into the opposite hand. After the injection of Beer's solution, the state of sensory block in the innervation range of Median, Radial, Ulnar, and Musculocotaneus nerves was evaluated by the Pin Prick method to create complete anesthesia and this time interval was recorded. After the completion of anesthesia, the proximal cuff was inflated again, the distal cuff was deflated and the surgeon was allowed to start work. If the patient reported some reduction in pain, but due to reasons such as anxiety, he did not have suitable conditions, 1 mg of midazolam and 50 micrograms of intravenous fentanyl were prescribed. If proper operation conditions were not created by prescribing these compounds, the person was excluded

from the study by mentioning the reason and the patient was operated on under general anesthesia. During the procedure, additional oxygen was given to the patient through a face mask. At this stage, the intensity of the patient's pain was evaluated and recorded by the anesthesia technician at intervals of every 10 minutes using numerical scoring criteria. During the surgery, in dealing with the possible pain of the patient, the following method is used: No special action was taken for pain intensity of 3 or less. For pain intensity of 4 and above, 50 micrograms of intravenous fentanyl were prescribed to the patient, and 5 minutes later, it was re-evaluated, if the pain intensity was above 4, the same dose of fentanyl was administered again, and if the pain intensity did not decrease below 4 after 5 minutes,. The patient was excluded from the study.

After transferring the patient to the recovery room, pain intensity was recorded every 15 minutes to 1 hour. During the stay in the recovery room, the time interval between the deflation of the tourniquet and the patient's first request for accommodation was also recorded. During the period of the patient's stay in the recovery room and after that in the inpatient ward until the end of the first 24 hours after the operation, any time the patient's pain intensity was 3 or less, no special action was taken, if the patient's pain intensity was from 4 to 7, 1 mg of intravenous morphine was injectec to the patient every 5 minutes until the pain intensity reached less than 4. If the patient's pain intensity was more than 8, 2 mg of morphine was injected every 55 minutes until the patient's pain intensity was below 8.

After the recovery time, the patient was transferred to the department and in the department, a venous PCA pump with the following specifications was prepared for the patient: 0.5 mg/mL morphine solution was prepared in a 20 ml syringe and installed on the pump. The patient was recorded by the personnel at time intervals in the first 6 hours every hour, from 6 to 12 hours every 2 hours, and after that until the end of 24 hours every 4 hours. Data such as pain intensity and the amount of morphine consumed were recorded. Every 4 hours, the occurrence of side effects of morphine (such as reduction of breathing rate to less than 10 per minute, nausea, vomiting, drowsiness, and urinary retention) and ketorolac (such as headache, drowsiness, dyspepsia, digestive system pains) and taking action was checked and recorded in dealing with them. In the end, the patient's overall satisfaction with the anesthesia method used and the pain control method after the operation was evaluated.

Information and descriptive statistics of patients were expressed as mean and standard deviation for quantitative variables and as number and percentage for descriptive variables. After Kolmogorov Smirnov test to determine the normality of the data, if the distribution of relevant data was not normal, Kruskal-Wallis test was used. The comparison of the variables between the three groups under study was done using a non-parametric test. Mann-Whitney test was used to compare two groups and determine different groups together. Chi-square test was used to compare qualitative variables. ANOVA was used to compare pain intensity averages based on numerical pain scale. Data analysis, both descriptive and analytical, was done using SPSS statistical software version 21. The significance level was set below 0.05.

Results

Ninety-six patients were included in this study, 64 (66.7%) men and 32 (33.3%) women. The average age of the patients was 35.89 ± 13.38 years (range 16 to 74 years). The average age of the patients in the groups receiving lidocaine (control group) was 33.68±11.14, in the topical lidocaine and ketorolac group 34.93±15.51 years, and in the group receiving lidocaine and intravenous ketorolac 39.06±12.95 years. The average weight of all patients was 66.84±11.77 kg.

Trauma patients were 98.9% of the 95 patients. The only non-traumatic patient was in the control group. The comparison of gender variables and type of traumatic injury between the three investigated groups showed that

Table 1. *Characteristics of patients in the three study groups.*

Index during intervention	Total patients	Control group	Topical ketorolac group	Intravenous ketorolac group
Tourniquet closing time (minutes)	2.1±1.73	1.87±2.07	1.68±1.25	2.75±1.64
Drug injection time (minutes)	3.21±2.29	4.06±3.37	2.62±1.51	2.62±1.09
Painless time (minutes)	4.87±2.53	4.9±2.76	4.87±2.79	4.84±2.04
Received midazolam (mg)	1.04±0.77	1.35±0.07	0.93±0.89	0.83±0.63
Fentanyl received (mg)	61.3±47.69	85.48±50.32	56.48±47.38	41.93±34.39
Duration of closing the tourniquet (minutes)	44.35±10.5	43.54±14.19	44.03±9.16	45.48±7.11

in terms of gender, 23 patients (71.9%) in the intravenous ketorolac group, 20 patiens (62.5%) in the topical ketorolac group, and 21 patients (65.6%) in the lidocaine group were male. In terms of traumatic injury, there were 32 people (100%) in the intravenous and local ketorolac group and 31 people (96.9%) in the lidocaine group (p=0.35), but no statistically significant differences were observed.

The variables of age and weight were examined between the three groups. The variable age was 37 years in the intravenous ketorolac group, 28 years in the topical ketorolac group, and 32 years in the lidocaine group (p=0.08), and the variable weight was 66.5 kg in the intravenous ketorolac group, 67.5 in the topical ketorolac group, and 71 kg in the lidocaine group (p=0.45). Thus, no statistically significant difference was observed.

Table 1 shows average time of closing and inflating the tourniquet, time of drug injection and time of closing the tourniquet until the onset of analgesia in all the patients in the study. Since some patients felt pain reduced to some extent after receiving the medicine of their group, but due to reasons such as anxiety, they did not have suitable conditions to participate in the study, so these patients were given 1 mg of midazolam and 50 mg of midazolam. Intravenous gram of fentanyl was prescribed to find suitable conditions to continue the study.

Since the variables of tourniquet closure time, drug injection, time interval from tourniquet closure to analgesia, the amount of midazolam and fentanyl received and the duration of tourniquet closure time after checking for normality using the Kolmogorov Smirnov test, determining how and stretching and it was found that leaf history graphs do not have a normal distribution. Therefore, the comparison of the mentioned variables between the three studied groups was done using the Kruskal-Wallis non-parametric statistical test, and the results of this comparison are given in Table 2. As can be seen, there is a significant difference between time of drug injection (lidocaine in the control group, topical ketorolac in the RK group and intravenous ketorolac in the IVK group), and time to feel pain and duration of closing the tourniquet between the three studied groups based on the Kruskal-Wallis test. The mean tourniquet closing time between the three groups showed a significant difference with p=0.001, which by comparing this variable between the three groups using the non-parametric Mann-Whitney U test showed that this difference between the intravenous ketorolac groups and the control group (0.0022 more patients were unable to continue the study due to prolonged operation and other reasons p = 0.001) and topical ketorolac (p = 0.001).

There is also a significant difference in the mean midazolam received between the three groups (p=0.008). Comparing the groups two by two using the Mann-Whitney U test showed a significant difference between the control group, the topical ketorolac group (p=0.015) and the intravenous ketorolac group (p=0.004). But the two groups receiving topical ketorolac and intravenous ketorolac had no significant difference. The median amount of fentanyl received also has a significant difference between the three groups with (p=0.001) as shown in Table. 2, which was determined by comparing the groups two by two with the Mann-Whitney U test that this difference is caused by the difference between the groups. control group with topical ketorolac (p=0.015) and control group with intravenous ketorolac (p=0.001).

After selecting the patients, after receiving the desired drug according to the group placed in it, in the pre-surgery assessment, due to reasons such as not feeling the reduction of pain and anxiety, some patients did not have the necessary conditions to continue the work based on the Bier block method and were excluded from the study. Some of them were excluded from the study due to operation problems. From the total of 96 patients present at the beginning of the study and before the study, 7 patients were withdrawn from the study after receiving the drug and before the outcome was performed, and of these 7 patients, 2 patients were in the control group, 3 patients were in the topical Ketorvalek group, and 2 people were in the intravenous catheter group. After the start of surgery, 2 more patients were unable to continue the study due to prolonged operation and other reasons. Therefore, considering that 9 patients were excluded from the study, only 87 remained in the study. By

Table 2. *Studied characteristics of the patients during the intervention in the three study group.*

Index during intervention	Control group Med(Q1-Q3)	Topical ketorolac group Med(Q1-Q3)	Intravenous ketorolac Med(Q1-Q3)	p-Value
Tourniquet closing time(minutes)	1.5(0.25-2)	1(1-2)	2(2-3)	0.001
Drug injection time (minutes)	3(2-4)	3(2-4)	2(1-3)	0.22
Painless time(minutes)	5(3-6)	5(3-6)	5(3.25-6)	0.98
Received midazolam (mg)	1(1-2)	1(0-1)	1(0-1)	0.008
Fentanyl received(mg)	100(50-100)	100(1-100)	90(0-100)	0.001
Duration of closing the tourniquet (minutes)	43(40-50)	45(40-45)	45(40-50)	0.44

comparing the total number of people who were excluded from the study using the Chi-square test between the three investigated groups, it was observed that the group in terms of people leaving the study, they are the same and have no difference (p = 0.037 and x2 = 1.97). After the surgery in the recovery room, the average time interval between emptying the tourniquet and the patient's first request to receive pain medication was 39±36 It is 70.83 minutes and the maximum time interval for receiving housing is 130 minutes (Table 2). The total amount of morphine consumed every 5 minutes in the recovery room of the remaining patients in the study is on average 1.3 ± 1.7 mg with a minimum of 0 and a maximum of 10 mg.

The comparison of the time of the first pain relief request and the amount of morphine consumed after the intervention in the operating room between the three groups was investigated. The time of the patients' first request to receive painkillers was 90 minutes in the local and intravenous ketorolac group and 70 minutes in the lidocaine group (p=0.63). The amount of morphine received was one unit in the local ketorolac group, two units in the control group, and no morphine was consumed in the intravenous ketorolac group (p=0.02). There is no significant difference between the tourniquets, but Table 3 shows that the amount of morphine received is significantly different between the groups (p=0.02 and X2=7.58). The score of numerical scale of pain in the recovery room, taking into account the time intervals of repeating the measurement, was performed using the statistical test of analysis of variance with repeated measurement (Repeated ANOVA). There is a significant difference in pain (p<0.001) and the effect of time is also significantly different with p<0.001.

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After the recovery time and transfer of patients to the ward, the amount of morphine consumed through the PCA pump, intravenously, up to 24 hours for patients with time intervals of one hour, in the first 6 hours, every 2 hours from 6-12 and every 4 hours until The end of 24 hours was recorded. Comparison of the amount of morphine consumed through the PCA pump, taking into account repeated measurements using the Repeated ANOVA test between the three studied groups, shows that the difference of this variable between the studied groups is significant with p<0.001, and the effect of time is also significant p<0.001. By comparing the two groups under investigation using the Bonferroni test, it was determined that the observed difference between the groups in terms of the amount of morphine consumed through PCA is due to the difference between the control group and the topical ketorolac group with a mean difference of p<0.001 and a significant difference in the control group and the intravenous ketorolac group have a mean difference of 0.39, 0.25 and p=0.02, which is significantly higher in the control group.

By examining the patients in the study in terms of the occurrence of complications related to morphine consumption, including drowsiness, nausea and vomiting, urinary retention and itching, none of the patients reported drowsiness during the measurement stages.Regarding the occurrence of nausea and vomiting, a total of 3 patients reported this complication, 2 cases were in the control group and one case was in the group receiving topical ketorolac. In the entire measurement process, no significant difference was observed between the groups in terms of the occurrence of nausea and vomiting after morphine administration. In terms of the occurrence of urinary retention complications following morphine administration, a total of 4 cases were observed, all of which were in the control group, and none of the patients in the ketorolac receiving groups reported this complication. In terms of the occurrence of this complication, no significant difference was observed between the groups.

Regarding the occurrence of itching after morphine administration, 5 cases were reported in all patients, all

Table 3. *Status of patients in terms of first request to receive painkillers and amount of morphine after intervention.*

Qualitative variable	Total patients	Control	Topical ketorolac	Intravenous ketorolac
Time of first request for housing	70.83±39.36	67.11±39.67	78.04±26.87	68.66±46.93
Amount of morphine	1.30±1.77	43.54±14.19	44.03±9.16	45.48±7.11

of which were in the control group. By performing the chi-square test, only in the third stage of the investigation with 3 cases of itching in the control group, this group showed a significant difference in terms of the occurrence of itching compared to the other two groups (intravenous and topical ketorolac) (p=0.04). Complications related to ketorolac administration including dyspepsia, headache, abdominal pain, indigestion and heartburn were investigated. that only one case of dyspepsia occurred in the group receiving topical ketorolac and none of the other side effects occurred after the administration of ketorolac.

Discussion

The aim of this study was to compare the analgesia effect of ketorolac in intravenous injection. And when it is added to lidocaine in Bier block, it is in the surgery of traumatic injuries of the upper limb. Intravenous local anesthesia in the form of Bier block using lidocaine and ketorolac is one of the techniques used in this study to evaluate the quality of anesthesia and postoperative analgesia in traumatic hand surgery. Block through intravenous local anesthesia using ketorolac is a useful minimally invasive technique for patients with impaired sympathetic reflexes.[13] This study was conducted on 96 traumatic patients undergoing hand surgery. The effect of topical and intravenous administration of lidocaine and ketorolac was compared. The average age of the patients was 35.89±13.38 years, the youngest was 16 years old and the oldest was 74 years old. Most of the patients (66.7%) were male and there was no difference between the 3 groups in terms of age and gender distribution. In this study, the average time to inflate and deflate the tourniquet cuff in all patients was 44.35±10.5 minutes, and all groups were similar in this respect. Therefore, this variable cannot affect the results of the present study, including side effects and pain intensity after surgery. Also, other factors such as the average injection time of the drugs used in each group, the interval between closing the tourniquet cuff and its inflation, the type of injury in the patients (traumatic and non-traumatic), the groups receiving ketorolac (topical and intravenous) and the control group differed from each other. did not show and was similar. In the present study, administration of ketorolac locally in the Bier block technique was able to prolong the time of the first request to receive painkillers by about 10 minutes on average compared to the group receiving intravenous ketorolac and the group receiving only lidocaine. Also, this time was longer in patients receiving intravenous ketorolac by almost one minute compared to the control group, but none of these differences were statistically significant (p>0.05). In the study of Amer et al.,[14] the administration of ketorolac in the same dose as the present study (30 mg) along with lidocaine was slightly more useful than the administration of lidocaine alone, and the average time needed to inject the first analgesic was longer in Reuben's study.[15] This was not observe in Rivera et al. study, which was performed in non-trauma patients, the time of pain relief was longer in the ketorolac group than in the control group,[16] the addition of ketorolac improved local anesthesia both in terms of the drug dose and pain after surgery.[15]

In the present study, administration of ketorolac reduced pain and reduced the need for morphine after surgery, and this difference in pain intensity is not related to the method of administration of ketorolac. In the Reuben study, the amount of analgesia received in the ketorolac group through intravenous local anesthesia was lower,[15] the Jankovic study showed that the addition of ketorolac and dexamethasone compared to the addition of ketorolac alone to lidocaine required postoperative analgesia. It significantly reduces intravenous local anesthesia,[17] but Amer et al., who in his study compared the effects of ketorolac and tramadol in intravenous local anesthesia technique, added tramadol to lidocaine in reducing the narcotic after 24 hours. It was found to be better than the addition of ketorolac from surgery.[14] The use of ketorolac in intravenous local anesthesia technique creates additional analgesia. According to Connelly and his colleagues, this therapeutic effect of the combination of lidocaine and ketorolac is caused by ketorolac, because lidocaine alone cannot have this effect.[13]

In the present study, the pain intensity was recorded according to the numerical scoring criteria up to one hour after the end of the surgery, every 15 minutes. In all patients and in all 4 measured stages, the highest pain intensity was observed 45 minutes after the operation (3rd measurement stage). The score up to one hour after the operation in the group receiving lidocaine was significantly higher than the groups receiving ketorolac, but there was no difference between the two groups receiving ketorolac. Therefore, based on this study, it can be said that ketorolac provides effective analgesia in the post-operative period in the Bier block method. Also, after being transferred to the inpatient department, these patients were examined for pain intensity based on numerical pain criteria until 24 hours after the operation, and a significant difference in pain intensity was observed between the studied groups and the measurement times. The control group reported significantly higher pain intensity than the other two groups. In his study, as in the present study, Reuben observed less pain intensity in the group receiving ketorolac in the intravenous local anesthesia technique after opening the tourniquet and up to one hour after the end of the surgery.[15] Also, Rivera et al. and Ahmad et al. in their studies up to one hour after the operation, they achieved such a result.[16,18] In the Amer et al. study, the intensity of pain in the group receiving Tramadol was better than that of ketorolac, but this intensity was better in the group receiving ketorolac than in the group of lidocaine alone.[14] It is believed that lidocaine alone in intravenous local anesthesia has a short period of postoperative analgesia, and its combination with another drug is necessary to prolong this period,[13] however, a

meta-analysis study by McCarthy et al. showed that injection of lidocaine reduces drug use.[19] Lidocaine injection also results in earlier return of bowel movement, faster recovery and shorter hospital stay. In general, it was found that intravenous injection of lidocaine during surgery is safe and useful in patients undergoing abdominal surgery. Patients receiving lidocaine have less pain and require less post-operative analgesia equipment and intra-operative anesthesia equipment, but this drug alone cannot create an anesthesia time longer than the block time, and therefore the results of ketorolac are an effective and useful drug for creating Analgesia is longer in patients undergoing surgery in the Bier block technique.[19] Reuben et al. also states that ketorolac provides effective postoperative analgesia when added to lidocaine in hand surgeries in this manner.[15] In the inpatient department, morphine was administered in the form of a 0.5 mg/mL solution through the PCA venous pump to control the patients' pain. The amount of morphine received to control pain in this way was significantly higher in the control group, and in other words, the administration of ketorolac significantly reduced the need for morphine consumption in these patients. In Reuben et al. and Ahmad' et al. studies, the need for fentanyl in recovery was lower in patients receiving ketorolac than in the control group.[15,18] Intravenous injection of narcotic causes less fluctuations in the quality of analgesia, but it requires the use of more advanced equipment and experienced personnel to achieve the desired results. Less analgesia is produced by using local anesthetics or narcotics, but may be accompanied by hypotension and respiratory failure. In local intravenous anesthesia, all these side effects can be avoided,[16] however, the technique of local intravenous anesthesia is somewhat questioned due to the side effects associated with the drugs used in it, which, of course, with the introduction of lidocaine hydrochloride, it was recognized as a safe and reliable method.[20] In Guay's study, the complications of intravenous local anesthesia were investigated and the complications of convulsions at a dose of 1.4 mg/kg or higher, cardiac arrest and death were mentioned for lidocaine.[21]Administering ketorolac topically can probably reduce the incidence of side effects along with providing analgesia. It is not known whether the analgesia represents a pharmacological effect of ketorolac at the surgical site or is a prophylactic analgesia effect. The systemic half-life of ketorolac is 4-6 hours. Most of the side effects of ketorolac occur in its systemic use in high doses or its long-term use, but by limiting the administration of this drug to the surgical area, a higher local concentration is obtained than that obtained in systemic administration, and its systemic side effects is also prevented.[16] In this study, the side effects of ketorolac administration including headache, dyspepsia, abdominal pain and indigestion were investigated, except for one case of dyspepsia in the last stage of measurement after surgery, another complication was observed in the control group. It was not possible and based on this, in addition to having advantages such as cheapness, effectiveness, reliable and safe drug, ketorolac prescription can also be considered in creating analgesia in intravenous local anesthesia. In Ahmad et al. study, no systemic or local side effects were observed for ketorolac following intravenous local anesthesia.[16] In Connelly et al. study, no specific and dangerous side effects were observed except dizziness and confusion,[13] In Rivera et al. study,[18] only skin bruising was observed. This complication was more in the control group than in the ketorolac receiving group, although this difference was not significant,[18] so it can be seen that the administration of ketorolac is an acceptable drug in terms of side effects. Based on the present study, by examining the overall satisfaction of the patients with the quality of analgesia during and after the operation and with the anesthesia method received, a total of 12.6% expressed complete satisfaction and 67.8% expressed partial satisfaction, but 19.5% of the patients were not satisfied with the resulting situation and this amount Dissatisfaction does not seem acceptable. In general, the level of satisfaction was better among patients receiving topical ketorolac, but this difference was not significant. The quality of analgesia in intravenous local anesthesia using ketorolac and lidocaine depends on the place of drug injection and the place of closing the tourniquet.

In conclusion, the administration of ketorolac reduces the intensity of postoperative pain in the recovery room and transfer to the inpatient ward, and reduces the amount of morphine received by patients, but the time of the first request for pain relief by the patient and it does not significantly delay and does not affect the overall satisfaction of patients with the quality of analgesia during and after the operation and satisfaction with the anesthesia method they received.

List of acronyms

PCA - patient-controlled analgesia
NRS - numerical rating scale

Contributions of Authors

All authors have read and approved the final edited typescript.

Acknowledgments

The authors thank the patients who volunteered for the study.

Funding

The authors received no funding for this work.

Conflict of Interest

The authors declare no financial, personal, or other conflicts of interest.

Ethical Publication Statement

We confirm that we have read the Journal's position on issues involved in ethical publication and affirm that this report is consistent with those guidelines.

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Submission: September 3, 2022
Revision received: September 16, 2022
Accepted for publication: September 16, 2022