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Comparison of Two Different Concentrations for Foot and Ankle Surgeries During Intravenous Regional Anesthesia (IVRA): A Randomized Cohort Study

İntravenöz Rejyonel Anestezi (IVRA) Sırasında Ayak ve Ayak Bileği Ameliyatları için İki Farklı Konsantrasyonun Karşılaştırılması: Randomize Kohort Çalışma

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ABSTRACT

Aim: Intravenous regional anesthesia (IVRA) is not commonly preferred in the lower extremity because of the toxic risks of high-dose local anesthetics. This study aimed to compare the use of two different concentrations of anesthetics with additional tourniquet application to reduce local anesthetics amount during the IVRA method for short-term foot and ankle surgeries.
Material and Methods: In this prospective study, 40 patients were allocated to two groups with different concentration formulations of 200 mg lidocaine hydrochloride (Group 30 and Group 20). The groups were compared in terms of demographic data, tourniquet pain, operation time, hemodynamic indicators, and sedo-analgesia needs.
Results: Demographic data were similar in the two groups. The mean tourniquet pain time was 41.66±6.61 minutes in Group 20 (n=9) and 36.76±7.17 minutes in Group 30 (n=13) (p=0.120). Perioperative sedo-analgesia consumptions were similar between the groups: weight-adjusted before/after tourniquet pain (p=0.390, p=0.207, p=0.536, and p=0.176), weight-adjusted/none total amount (p=0.425, p=0.578, p=0.268, and p=0.612), per minute before/after tourniquet pain (p=0.075, p=0.506, p=0.354, and p=0.055), for propofol and remifentanil, respectively. There was a significant difference between the propofol and remifentanil consumption per minute before and after the tourniquet pain in both groups: 5.61±1.67 and 14.58±6.62 mg/min propofol (p=0.001), and 4.79±1.69 and 7.86±1.55 mcg/min remifentanil (p=0.001), respectively. No patient had signs of local anesthetic toxicity.
Conclusion: Low-dose sedo-analgesia can be used by a modified IVRA method in the management of tourniquet discomfort that may occur until the tourniquet pain develops.
Keywords: intravenous regional anesthesia, additional tourniquet, short-term foot and ankle surgery, tourniquet pain, lower extremity.

ÖZ

Amaç: Intravenöz rejyonel anestezi (IVRA), yüksek doz lokal anesteziklerin toksik riskleri nedeniyle alt ekstremitede yaygın olarak tercih edilmemektedir. Bu çalışmada, kısa süreli ayak ve ayak bileği ameliyatlarında IVRA yöntemi sırasında lokal anestezik miktarını azaltmak için iki farklı anestezik konsantrasyonunun ek turnike uygulaması ile karşılaştırılması amaçlandı.
Gereç ve Yöntemler: Bu prospektif çalışmada, 40 hasta 200 mg lidokain hidroklorürün farklı konsantrasyon formülasyonlarına sahip iki gruba ayrıldı (Grup 30 ve Grup 20). Gruplar demografik veriler, turnike ağrısı, operasyon süresi, hemodinamik göstergeler ve sedo-analjezi ihtiyaçları açısından karşılaştırıldı.
Bulgular: Demografik veriler her iki grupta da benzerdi. Turnike ağrı süresinin ortalaması Grup 20'de (n=9) 41,66±6,61 dakika ve Grup 30'da (n=13) 36,76±7,17 dakika idi (p=0.120). Perioperatif sedo-analjezi tüketimleri gruplar arasında benzerdi: propofol ve remifentanil için sırasıyla, kiloya göre turnike ağrısı önce/sonra (p=0,390; p=0,207; p=0,536 ve p=0,176), kiloya göre/yok toplam miktar (p=0,425; p=0,578; p=0,268 ve p=0,612), dakika başına turnike ağrısı önce/sonra (p=0,075; p=0,506; p=0,354 ve p=0,055). Her iki grupta da turnike ağrısı öncesi ve sonrası dakika başına propofol ve remifentanil tüketimi arasında önemli bir fark vardı: sırasıyla, 5,61±1,67 ve 14,58±6,62 mg/dk propofol (p=0,001) ve 4,79±1,69 ve 7,86±1,55 mcg/dk remifentanil (p=0,001). Hiçbir hastada lokal anestezik toksisite bulguları yoktu.
Sonuç: Düşük doz sedo-analjezi, turnike ağrısı gelişene kadar oluşabilecek turnike rahatsızlığının tedavisinde modifiye bir IVRA yöntemi ile kullanılabilir.
Anahtar kelimeler: intravenöz rejyonel anestezi, ek turnike, kısa süreli ayak ve ayak bileği cerrahisi, turnike ağrısı, alt ekstremite.

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INTRODUCTION

Intravenous regional anesthesia (IVRA) is regional anesthesia that can be created by eliminating nerve conduction and pain sensation due to the tourniquet. First, the tourniquet is placed on the proximal extremity, keeping to a constant pressure above the systemic arterial pressure, then local anesthetic agents are administered into the venous system. IVRA is a preferable method because it is easy to apply in upper extremity surgeries, its effect starts and ends quickly, it provides effective anesthesia, and, finally, it has low preoperative morbidity and short postoperative hospital stay (1).

IVRA is more advantageous than general anesthesia since the airway remains open during the application, airway reflexes are protected, and the risk of aspiration is reduced in emergency patients whose fasting state is not suitable. It is frequently used in outpatient surgeries of the upper extremities due to its low cost, high (95%) chance of success, and low risk of complications and mortality (2).

Although the IVRA technique is similar in principle at the upper and lower extremities, the local anesthetic dose required for the lower extremity block is approximately twice more than that required for the upper extremity. The risk of local anesthetic toxicity increases if tourniquet leakage occurs or the tourniquet is deflated at the end of the short surgical period. Due to the need for a higher dose of local anesthetic, IVRA is rarely preferred in lower extremities to avoid the postoperative toxicity findings linked to higher doses. Modifications to the traditional IVRA method and changes to the amount of local anesthetics have been tried to reduce such side effects of local anesthetics (3).

We aimed to compare the use of two different regimens in the modified IVRA method with a tourniquet placed under the knee in addition to the traditional IVRA method to reduce the amount of local anesthetics used in foot and ankle surgeries.

MATERIAL AND METHODS

Patients

This prospective study was conducted in 2016 with the approval of the local ethics committee (approval numbers: 2015/351 and 2016/272). The patients, in whose cases a single-cuff proximal tourniquet was routinely used for a bloodless surgical field by an additional tourniquet in foot and ankle surgeries. The primary population for analysis is the so-called modified IVRA population. In the analysis, patients were grouped into two based on the concentration of anesthetics according to the modified IVRA principle: 200 mg lidocaine hydrochloride in 20 mL (Group 20, n=24) and 30 mL (Group 30, n=27) saline.

The primary outcome of the study was weight-adjusted analgesic consumption with a specific sedo-analgesia protocol before tourniquet pain. The secondary outcome of the study was weight-adjusted analgesic consumption with a specific sedo-analgesia protocol after tourniquet pain. Weight-adjusted sedo-analgesia consumption was quantified in propofol and remifentanil equivalents. This study was planned to compare the two groups where the anticipated difference was 30% in the hemodynamic values. Accordingly, the sample size of 20 patients in each group was required for a type I error (α) of 0.050 and a power of 80% in a two-sided design.

Patients were excluded if they met any of the following criteria: chronic disease associated with the liver, peripheral vascular diseases, neuromuscular diseases, bleeding disorder, over one-hour surgery time, American Society of Anesthesiologists (ASA) physical status III-IV, being younger than 16, and older than 60 years of age. The patients who had cognitive impairment or developmental delay, the non-cooperative patients with debile or senile dementia or head trauma, the foreign-speaking patients, the patients with preoperative pain scores greater than 0, and the patients with a history of fibromyalgia syndrome were excluded as well. A total of 11 patients were excluded from the study sample due to these criteria. The patients were randomly allocated into two groups in a way to include twenty patients in each one. The groups were compared in terms of the hemodynamic effects.

Measurements

Age, sex, weight, body mass index (BMI), and the ASA classification of the patients included in the study were recorded. Heart rate (HR), mean arterial pressure (MAP), and peripheral oxygen saturation (SpO_2) were recorded in the patients who were routinely monitored, and these values were saved as basal values. Intraoperative measured values were recorded every 5 minutes.

Anesthesia Management

Patients were given the infusion of fluid with a 20 or 22-gauge cannula from the back of the hand as 0.9% NaCl 4-6 mL/kg/h. Patients were prepared for the operation by applying premedication with 0.03 mg/kg midazolam. Patients were given 40% O_2 3 L/min from a nasal cannula with the help of an anesthesia machine (GE Datex-Ohmeda S5 Avance). A 22-gauge cannula was used to establish vascular access from the operated extremity, and a single cuff pneumatic tourniquet was placed on the proximal side of the extremity. After keeping the extremity above the head level for 3 minutes, it was started being wrapped with an Esmarch bandage starting from distal to proximal. 1 mcg/kg fentanyl was administered as standard. The single-cuff proximal tourniquet was inflated to maintain a value that is 100 mmHg higher than systolic arterial pressure or a maximum value of 300 mmHg. After dissolving the Esmarch bandage, dorsalis pedis and under nail capillary fillings were controlled to assess the adequacy of the tourniquet pressure. Lipid Rescue Kit was kept ready for possible local anesthetic toxicity, based on the protocol determined by the American Society of Regional Anesthesia and Pain Medicine (ASRA).

An additional tourniquet was applied under the knee level in the non-circulating extremity after proximal tourniquet inflation. The local anesthetic solution was administered by giving 1 mL in 3 seconds. The additional distal tourniquet was held at a pressure of 100 mmHg above the systolic value, following the injection of the local anesthetic solution. Surgery was started after an adequate anesthesia level was reached, being checked with the pinprick test. Perioperative nausea and vomiting, skin rash, headache, dizziness, tinnitus, metallic taste, and numbness in the tongue were also evaluated for local anesthetic toxicity.

Various operation time intervals were determined based on certain milestones. The duration from the administration of local anesthetic solutions to the surgical incision was

considered the time to start the surgery. The duration from the surgical incision to the proximal tourniquet deflation was considered as the surgery time. The duration from the proximal tourniquet inflation to the proximal tourniquet deflation was considered the tourniquet time. The duration from the proximal tourniquet inflation to the time when tourniquet pain developed was considered the tourniquet pain time.

Procedure

The pain status of patients was evaluated using the visual analogue scale (VAS). No additional analgesic drug was administered to the patients with a VAS score between 0 and 2. In the patients with a VAS score between 3 and 5, tourniquet-related discomfort was considered, and 3 mg/kg/h propofol and 3 mcg/kg/h remifentanil infusion were initiated. Tourniquet pain was thought to occur when severe, blunt pain occurs in the tourniquet area or just distal to the cuff, or the VAS score was above 5 despite an adequate anesthesia level or the patient's being uncomfortable despite the infusion. In these patients, 1 mg/kg propofol and 0.25 mcg/kg remifentanil were started for induction, and 3 mg/kg/h propofol and 6 mcg/kg/h remifentanil for infusion. Before the induction, the patient was observed every 5 min with simultaneous bispectral index score (BIS) and Ramsey sedation scale (RSS). Propofol was given in 0.4 mg/kg bolus dose in 3 minutes. The infusion rate was increased to 0.5 mg/kg/h until a target BIS level of 60 to 75 was reached in the two groups. At levels below the target values, the propofol infusion rate was reduced to 0.5 mg/kg/h in 5 min. The sedo-analgesia needs used in our clinic-specific protocol were compared with the help of BIS monitoring.

Tramadol citrate 100 mg was routinely administered to all patients just before the end of the operation. At the end of the operation, a local anesthetic was given to the surgical incision line just before the proximal tourniquet was deflated. Bupivacaine hydrochloride 2.5 mg/mL was applied to help postoperative pain control.

Vital signs, toxic symptoms, and postoperative pain status were evaluated postoperatively for two hours. After the deflation of the proximal tourniquet at the end of the operation, patients were transferred to the post-anesthesia care unit (PACU) after VAS and RSS scoring. Fentanyl 1 mcg/kg was given as a rescue analgesic to the patients with pain during observation. After PACU, patients with an RSS score of 2-3 were referred to their services for standard follow-up and treatment by nurses who were not associated with the study.

Statistical Analysis

The Shapiro-Wilk test was used to check the conformity of continuous variables to normal distribution. The Student's t-test was used to compare normally distributed variables, and the Mann-Whitney U test was used for non-normally distributed variables. The relationships between categorical variables were tested with the chi-square test. To compare the numerical measurements obtained at different times, a repeated measurement variance analysis was used for variables with normal distribution, and Freidman tests were used for variables that were not normally distributed. For statistical analysis, the IBM SPSS Statistics for Windows, version 22.0, statistical software was used, and a p-value <0.050 was considered statistically significant.

RESULT

Demographic data and operation times were shown in Table 1. The distribution of patients numbers in terms of the surgical operations for Group 20-Group 30, were benign soft-tissue mass excision (Morton neuroma, glomus tumor, ganglion cyst, etc.) 1-4, deformity surgery (hallux valgus, hammer finger, claw toe, etc.) 2-2, small bone fracture fixation 4-3, isolated lateral 3-1 and medial 2-3 malleolus fracture fixation (plate, screw, etc.), foot 3-4 and ankle 5-3 implant removal (plate, screw, etc.), respectively.

It was seen that the proximal tourniquet was not deflated even though the operation was completed within 30 minutes after the injection of local anesthetic solution in the patients who received IVRA.

No tourniquet pain was seen in the two groups before 30 minutes. No tourniquet pain was seen in Group 20 at 30 minutes, but two patients developed tourniquet pain at the 35th minute. In Group 30, tourniquet pain developed in three patients at the 30th minute and the 35th minute in six patients. Tourniquet pain was more frequent in Group 30 than in Group 20 in earlier periods (Figure 1).

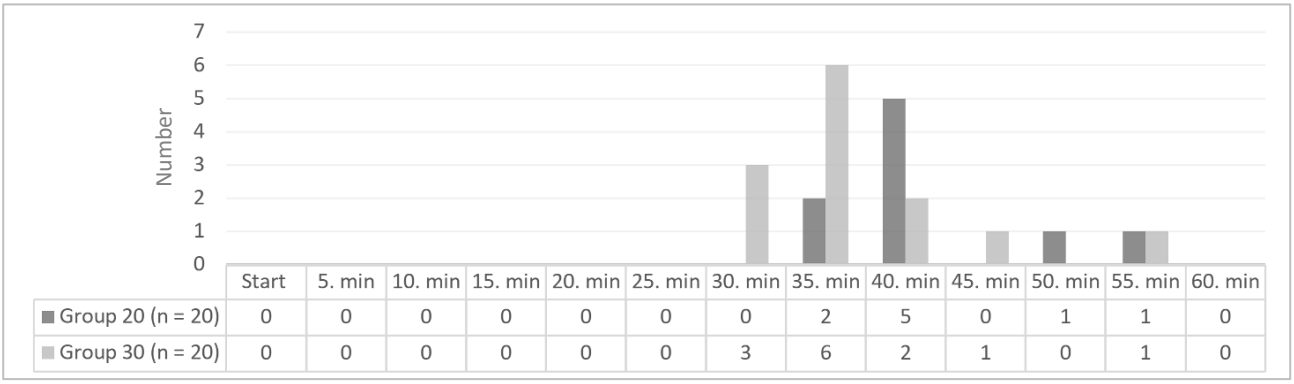
The mean tourniquet pain time was 41.66±6.61 minutes in Group 20 (n=9) and 36.76±7.17 minutes in Group 30 (n=13). There was no significant difference between the groups in terms of tourniquet pain (p=0.120).

In Group 30, a significant MAP increase occurred at the 35th minute (p=0.022). No significant difference was found between the groups in terms of MAP values in other periods. The difference between the groups in terms of hemodynamic parameters was shown in Figure 2.

Table 1. Demographic data and operation times

	Group 20 (n=20)	Group 30 (n=20)	p
Age (years), mean±SD	33.85±10.94	33.30±14.90	0.894
Gender (male/female), n (%)	12 (60) / 8 (40)	13 (65) / 7 (35)	0.744
Weight (kg), mean±SD	77.20±12.42	78.20±15.73	0.825
Height (cm), mean±SD	171.40±10.99	169.50±9.70	0.566
BMI (kg/m^2), mean±SD	25.95±3.53	26.90±4.50	0.463
ASA (I/II), n (%)	8 (40) / 12 (60)	11 (55) / 9 (45)	0.537
Time to start surgery (min), mean±SD	17.00±7.67	14.90±6.62	0.711
Surgery time (min), mean±SD	28.00±8.64	29.35±13.61	0.360
Tourniquet time (min), mean±SD	45.00±10.13	44.25±13.69	0.845
Tourniquet pain time* (min), mean±SD	41.66±6.61	36.76±7.17	0.120

SD: standard deviation, BMI: body mass index, ASA: American Society of Anesthesiologists, min: minute, *: Group 20 (n=9), Group 30 (n=13)



	Start	5. min	10. min	15. min	20. min	25. min	30. min	35. min	40. min	45. min	50. min	55. min	60. min
Group 20 (n = 20)	0	0	0	0	0	0	0	2	5	0	1	1	0
Group 30 (n = 20)	0	0	0	0	0	0	3	6	2	1	0	1	0

Figure 1. Time of tourniquet pain and distribution of patient numbers according to the groups

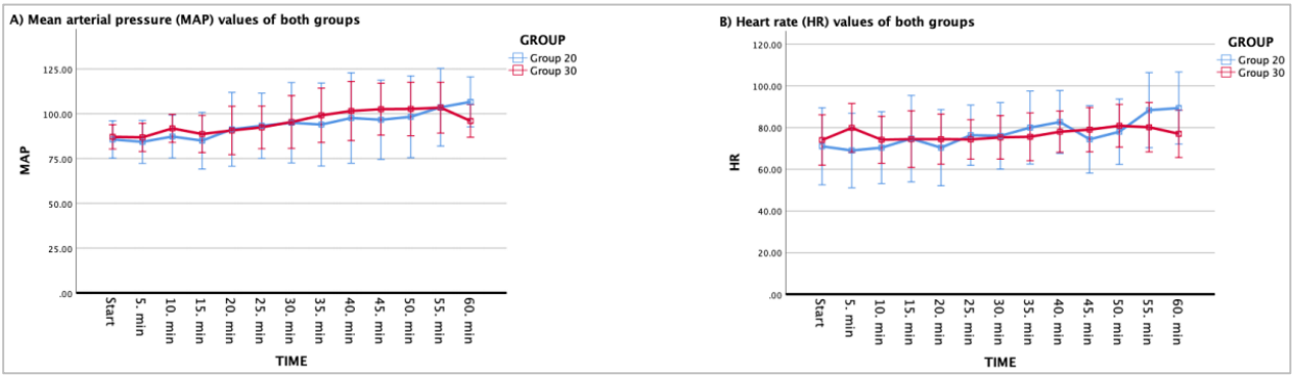


Figure 2. Mean arterial pressure (MAP) and heart rate (HR) values of both groups

Perioperative weight-adjusted sedo-analgesia consumption with a specific protocol before tourniquet pain was 2.76±0.58 mg/kg propofol and 2.51±0.88 mcg/kg remifentanil in Group 20 and 2.58±0.73 mg/kg propofol and 2.16±0.83 mcg/kg remifentanil in Group 30 (p=0.390, p=0.207, propofol, and remifentanil, respectively). Perioperative weight-adjusted sedo-analgesia consumption with a specific protocol after tourniquet pain was 2.00±0.81 mg/kg propofol and 1.03±0.81 mcg/kg remifentanil in Group 20 and 2.28±1.16 mg/kg propofol and 1.51±0.77 mcg/kg remifentanil in Group 30 (p=0.536, p=0.176, propofol, and remifentanil, respectively). There was no significant difference between the two groups in terms of perioperative weight-adjusted sedo-analgesia consumption before and after tourniquet pain (Table 2).

Perioperative weight-adjusted total sedo-analgesia consumption with a specific protocol was 3.66±1.28 mg/kg propofol and 2.97±0.95 mcg/kg remifentanil in Group 20 and 4.06±1.79 mg/kg propofol and 3.19±1.47 mcg/kg remifentanil in Group 30 (p=0.425, p=0.578, propofol, and remifentanil, respectively). Perioperative total sedo-analgesia consumption with a specific protocol was 278.91±95.55 mg propofol and 231.06±82.50 mcg remifentanil in Group 20 and 329.90±177.88 mg propofol and 249.22±135.21 mcg remifentanil in Group 30 (p=0.268, p=0.612, propofol, and remifentanil, respectively). There was no significant difference between the groups in terms of the total amount of perioperative sedo-analgesia consumption (Table 2).

Perioperative sedo-analgesia consumption per minute with a specific protocol before tourniquet pain was 5.08±1.43 mg/min propofol and 5.30±2.90 mcg/min remifentanil in Group 20 and 5.94±1.53 mg/min propofol and 4.82±1.41 mcg/min remifentanil in Group 30 (p=0.075, p=0.506, propofol, and remifentanil, respectively). Perioperative sedo-analgesia consumption per minute with a specific protocol after tourniquet pain was 16.45±9.21 mg/min propofol and 7.08±1.52 mcg/min remifentanil in Group 20 and 13.28±3.97 mg/min propofol and 8.40±1.39 mcg/min remifentanil in Group 30 (p=0.354, p=0.055, propofol, and remifentanil, respectively). There was no significant difference between the groups in terms of perioperative sedo-analgesia consumption per minute before and after tourniquet pain (Table 2).

Table 2. Propofol and remifentanil consumption (mean±SD)

	Group 20	Group 30	p
W-A Before TP			
Propofol (mg/kg)	2.76±0.58	2.58±0.73	0.390
Remifentanil (mcg/kg)	2.51±0.88	2.16±0.83	0.207
W-A After TP*			
Propofol (mg/kg)	2.00±0.81	2.28±1.16	0.536
Remifentanil (mcg/kg)	1.03±0.81	1.51±0.77	0.176
W-A Total Amount			
Propofol (mg/kg)	3.66±1.28	4.06±1.79	0.425
Remifentanil (mcg/kg)	2.97±0.95	3.19±1.47	0.578
Per Minute Before TP			
Propofol (mg/min)	5.08±1.43	5.94±1.53	0.075
Remifentanil (mcg/min)	5.30±2.90	4.82±1.41	0.506
Per Minute After TP*			
Propofol (mg/min)	16.45±9.21	13.28±3.97	0.354
Remifentanil (mcg/min)	7.08±1.52	8.40±1.39	0.055
Total Amount			
Propofol (mg)	278.91±95.55	329.90±177.88	0.268
Remifentanil (mcg)	231.06±82.50	249.22±135.21	0.612

SD: standard deviation, W-A: weight-adjusted, TP: tourniquet pain, *: Group 20 (n=9), Group 30 (n=13)

In Group 20, perioperative sedo-analgesia consumption per minute with a specific protocol was 5.61±1.67 mg/min propofol before tourniquet pain and 14.58±6.62 mg/min propofol after tourniquet pain. In Group 30, perioperative sedo-analgesia consumption per minute with a specific protocol was 4.79±1.69 mcg/min remifentanil before tourniquet pain and 7.86±1.55 mcg/min remifentanil after tourniquet pain. There was a significant difference between propofol and remifentanil consumption per minute before and after the tourniquet (p=0.001) (Table 3). Postoperative additional fentanyl was required in two patients in Group 20 and three patients in Group 30. None of the patients had signs of local anesthetic toxicity.

Table 3. Propofol and remifentanil consumption per minute before and after the tourniquet pain (mean±SD)

Consumption	Before (n=22)	After (n=22)	p
Propofol (mg/min)	5.61±1.67	14.58±6.62	**0.001**
Remifentanil (mcg/min)	4.79±1.69	7.86±1.55	**0.001**

DISCUSSION

IVRA is less preferred in lower extremity surgeries compared to upper extremity surgeries due to the high amount of local anesthetic used, which may be toxic. Although IVRA has lost its popularity with the use of several other regional approaches today, it is still considered an alternative due to its advantages such as ease of application, early recovery time, and low side effect profile. It can be used in cases with high comorbidity and where applying other regional approaches is risky (4).

The factors that limit the use of IVRA are toxic complications related to the local anesthetic agent, tourniquet pain, and postoperative pain management. In successful IVRA management, these parameters are chosen as the primary target (5). We aimed to compare two different concentrations that were used as part of the standard practice at our institution for foot and ankle surgeries with additional tourniquet application and the IVRA method supported by sedo-analgesia.

An increased likelihood of toxicity due to the high local anesthetic amount hampered the use of traditional IVRA in lower extremity operations (6). The Fellowship of the British Royal College of Anaesthetists (FRCA) recommended a dose of 200 mg of a 5% lidocaine solution for IVRA (7). In addition, no complications were observed in the use of the traditional IVRA method at a dose of 3 mg/kg in lower extremity surgeries (8). IVRA method between two tourniquets, first described by Bier in 1908, was reorganized for knee anesthesia as an inter-cuff technique (9). Arslan et al. (10) have found that the addition of ketamine to the traditional IVRA procedure in knee arthroscopy shortened the onset of sensory block and prolonged the initial analgesic requirement duration. Similar to our study, reducing the total amount of local anesthetic was also aimed by the modification and sedo-analgesia compared to the traditional IVRA in the lower extremity, which requires a high amount of local anesthetic in routine use.

It was reported that the distribution of the local anesthetic agent could be limited with the use of a modified IVRA technique using additional or temporary tourniquets in the upper extremity surgeries, resulting in lower local anesthetic use, and shorter duration of action, and higher quality of anesthesia (11). It has been shown that low anesthetic doses allowed the tourniquet to be deflated as early as 10 minutes (12). The use of a tourniquet under the knee did not increase the risk of local anesthetic leakage through the intraosseous space; in fact, it has been shown to provide a lower dose required to achieve a comparable level of anesthesia. Therefore, an under-knee tourniquet is as safe as the use of an above-knee tourniquet (13).

The main goal of the traditional double-cuff IVRA method, which requires a high amount of local anesthetics, is to reduce the tourniquet pain. Tourniquet pain is one of the most critical complications of tourniquet use and has two important components: tourniquet-related discomfort and real tourniquet pain. Tourniquet-related discomfort can be kept under control with low sedo-analgesia. The sedo-analgesic requirements of the use of a single-cuff tourniquet or double-cuff tourniquet for up to 40 minutes are similar. The required sedo-analgesic consumption also increases in direct proportion with time (14). In our study, although no difference was found between the groups, the sedo-analgesic consumption significantly increased after tourniquet pain developed in patients. Tourniquet pain time was 41.66±6.61 minutes in Group 20 and 36.76±7.17 minutes in Group 30.

The hypertensive tendency is linearly correlated with the increasing levels of tourniquet discomfort over time and this tendency may reach an uncontrollable level. The tourniquet pain can be observed for 60 minutes along with a hypertensive tendency that has an unknown cause and may develop even under general anesthesia depending on insufficient tourniquet tolerance (15). The hypertensive tendency might be prevented with the sedo-analgesia protocol in our study. There was a significant difference between the groups in terms of MAP values at around 35 minutes, but there was no significant difference at other time points. It may have resulted from the fact that tourniquet pain was more frequent in Group 30 than in Group 20 in earlier periods.

BIS monitoring with a hemodynamic follow-up is recommended in patients to avoid unwanted pain. The BIS monitoring has been reported to provide a more balanced anesthesia depth in terms of the required sedo-analgesic consumption and contribute to recovery from anesthesia, postoperative recovery, and orientation (16). We also benefited from BIS monitoring support in the detection and effective management of tourniquet pain and hypertensive tendency with the help of propofol and remifentanil infusion. No patient had any sign of local anesthetic toxicity.

The agent used for the infiltration of local anesthetic should have a slow transition to the plasma so that it has a long postoperative effect. Bupivacaine stays longer and provides long-term analgesia with more lipid-solubility and strong protein dependence in nerves (17). Bupivacaine hydrochloride 2.5 mg/mL was added to the incision line just before the skin and subcutaneous suturing in our study. This infiltration allowed early deflation of the tourniquet, as well as contributed to the control of postoperative analgesia where IVRA was insufficient. Two patients had postoperative additional fentanyl requirements, and there

was no significant difference between the groups in terms of postoperative analgesic need.

This study has several limitations. Firstly, a limiting factor was that only two different concentrations were compared. Another limitation was that there was no control group for comparison.

CONCLUSION

We can also use a modified IVRA approach with low-dose sedo-analgesia support in patient management until the tourniquet pain develops. We also think that the modified IVRA approach can be considered as an alternative method to other anesthetic approaches in high-risk patients by limiting the side-effect profile with a controlled amount of local anesthetic in short-term orthopedic surgery. We believe that the optimal approach can be found with modifications to the IVRA method applied in the lower extremity.

Main points:

- The use of an additional tourniquet reduces the local anesthetic amount.
- Reduced risk of local anesthetic toxicity.
- IVRA creates an alternative to lower extremity surgeries.

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