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Are peripheral nerve blocks effective in pain control of pediatric orthopedic tumor surgery?

Pediatrik ortopedik tümör cerrahisinin ağrı kontrolünde periferik sinir blokları etkili midir?

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ABSTRACT

Objectives: This study aims to evaluate the efficacy of ultrasound (US)-guided peripheral nerve blocks in postoperative analgesia after pediatric orthopedic tumor surgery.

Patients and methods: This retrospective study included 108 children (64 boys, 44 girls, mean age 10.23 years; range, 2 to 18 years) who were performed orthopedic tumor surgery under general anesthesia. The children were divided into two groups as those who were performed nerve block for postoperative pain control (group 1, n=54) and those who were performed intravenous analgesic (group 2, n=54). In group 1, nerve blocks were performed with bupivacaine 0.25%. In group 2, intraoperative acetaminophen 15 mg/kg was performed intravenously. Postoperative visual analog scale (VAS) scores, time to pain onset, nausea, vomiting, total analgesic consumption in 24 hours, and complications were recorded at first, second, sixth and 24th hours.

Results: Visual analog scale scores were higher in group 2 than group 1 at first, second, and sixth hours, but were not different at 24th hour. Mean time to pain onset was 10.2 hours in group 1 and 1.8 hours in group 2 ($p<0.05$). Mean time to pain onset and VAS values at first, second, sixth and 24th hours did not differ between nerve block types. Nausea and vomiting rates were not different between groups 1 and 2 (18.51% and 16.66%, respectively; $p=0.4$). Total analgesic consumption in 24 hours was higher in group 2 compared to group 1 (1.7 and 0.07 mg/kg, respectively; $p<0.05$).

Conclusion: Pain-free periods extending up to 10 hours provided by US-guided peripheral nerve blocks may help recovery while reducing postoperative analgesic use and their side effects.

Keywords: Nerve blocks, orthopedic tumor surgery, pediatric.

ÖZ

Amaç: Bu çalışmada, pediatrik ortopedik tümör cerrahisi sonrasında ameliyat sonrası analjezide ultrason eşliğinde uygulanan periferik sinir bloklarının etkinliği değerlendirildi.

Hastalar ve yöntemler: Bu retrospektif çalışmaya genel anestezi altında ortopedik tümör cerrahisi uygulanan 108 çocuk (64 erkek, 44 kız; ort. yaş 10.23 yıl; dağılım, 2-18 yıl) dahil edildi. Çocuklar ameliyat sonrası ağrı kontrolü için sinir bloğu uygulananlar (grup 1, n=54) ve intravenöz analjezik uygulananlar (grup 2, n=54) olmak üzere iki gruba ayrıldı. Grup 1'de sinir blokları bupivakain %0.25 ile yapıldı. Grup 2'de 15 mg/kg asetaminofen ameliyat sırasında intravenöz olarak uygulandı. Ameliyat sonrası görsel analog ölçeği (VAS) skorları, ağrı başlangıcına kadar geçen zaman, bulantı, kusma, 24 saatte toplam analjezik tüketimi ve olası komplikasyonlar birinci, ikinci, altıncı ve 24. saatlerde kaydedildi.

Bulgular: Görsel analog ölçeği skorları grup 2'de birinci, ikinci ve altıncı saatlerde grup 1'den daha yüksekti, ancak 24. saatte farklı değildi. Ağrı başlangıcına kadar geçen ortalama zaman grup 1'de 10.2 saat iken grup 2'de 1.8 saat idi ($p<0.05$). Ağrı başlangıcına kadar geçen ortalama zaman ve birinci, ikinci, altıncı ve 24. saatlerdeki VAS değerleri, sinir bloğu tipleri arasında farklılık göstermedi. Bulantı ve kusma oranları grup 1 ve 2 arasında farklı değildi (sırasıyla %18.51 ve %16.66, $p=0.4$). Yirmi dört saatte toplam analjezik tüketimi grup 2'de grup 1'e kıyasla daha yüksekti (sırasıyla 1.7 ve 0.07 mg/kg, $p<0.05$).

Sonuç: Ultrason eşliğinde uygulanan periferik sinir bloklarının sağladığı 10 saate kadar uzayan ağrısız dönemler ameliyat sonrası analjezik kullanımını ve bunların yan etkilerini azaltarak iyileşmeye yardımcı olabilir.

Anahtar sözcükler: Sinir blokları, ortopedik tümör cerrahisi, pediatrik.

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Postoperative pain is an important clinical problem in pediatric orthopedic tumor surgery. Effective management of pain provides advantages such as reduction of postoperative agitation, increased quality of life, and rapid onset of oral nutrition and early mobilization. In postoperative pain management, oral route is preferred in mild to moderate pain whereas regional or intravenous analgesia is preferred in severe pain.

Recently, peripheral nerve blocks have emerged as an alternative to intravenous pain treatment.[1] Hospitalization at home is a developing interest in care of oncologic patients. It reduces the stress of parental separation, postoperative infections, and the cost of hospitalization. However, pain remains the most common complaint in postoperative follow-up particularly in children. Regional anesthesia shows similarity between children and adults in terms of diminished morphine consumption in postoperative period. This type of analgesia is mainly reserved for major orthopedic surgery in both children and adults.[1,2]

Peripheral nerve block in pediatric patients is useful for several reasons such as providing adequate anesthesia and supporting postoperative analgesia, leading to lesser physiologic damage, and allowing faster recovery and early discharge. Nevertheless, only a limited number of studies are present on peripheral nerve block applications in children. A significant amount of pediatric patients exists in orthopedic oncology practice and pain treatment of this population is different from adults. Difficulty in dose adjustment, unexpected adverse effects, and leaving traces that may affect children's future lives are factors that restrict physicians in pain treatment procedures. Since oncologic pediatric patients are hospitalized for long durations, their psychological state is an obstacle for treatment. For pediatric patients, it is important to be discharged from the postoperative intensive care unit as soon as possible, being mobilized, and fed early. Therefore, it is necessary to minimize the systemic effects of analgesics while coping with pain.

In peripheral nerve block, ultrasound (US) application is easier in children because of their more superficial neural structures than adults. Ultrasound facilitates reaching neural structures and monitoring the distribution of the applied local anesthetic drug. Thus, the volume of local anesthetic needed and the frequency and severity of complications can be reduced. Furthermore, US use may increase the quality and success of peripheral nerve blocks.[3,4] In this study, we aimed to evaluate the efficacy of US-guided peripheral nerve blocks in postoperative analgesia after pediatric orthopedic tumor surgery.

PATIENTS AND METHODS

This retrospective study included 108 pediatric patients (64 boys, 44 girls, mean age 10.23 years; range, 2 to 18 years) who underwent elective orthopedic tumor surgery under general anesthesia at Dr. Abdurrahman Yurtaslan Ankara Oncology Training and Research Hospital between November 2012 and November 2017. Of the 108 patients, 54 who underwent US-guided peripheral nerve block for postoperative analgesia were identified from the records and named as group 1. The other 54 patients for whom peripheral nerve block was not applied but who received intravenous analgesics for postoperative analgesia were included as group 2. Exclusion criteria for nerve block were failure in obtaining consent from the patient or family, presence of antithrombotic therapy and impaired coagulation parameters, infection, previous surgery or anatomic deformation at the site of administration, neurologic disease, peripheral nerve disease, allergy history for local anesthetic drugs, contralateral diaphragm paralysis and/or pneumothorax, dyspnea, and reduced lung capacity. All patients were either classified

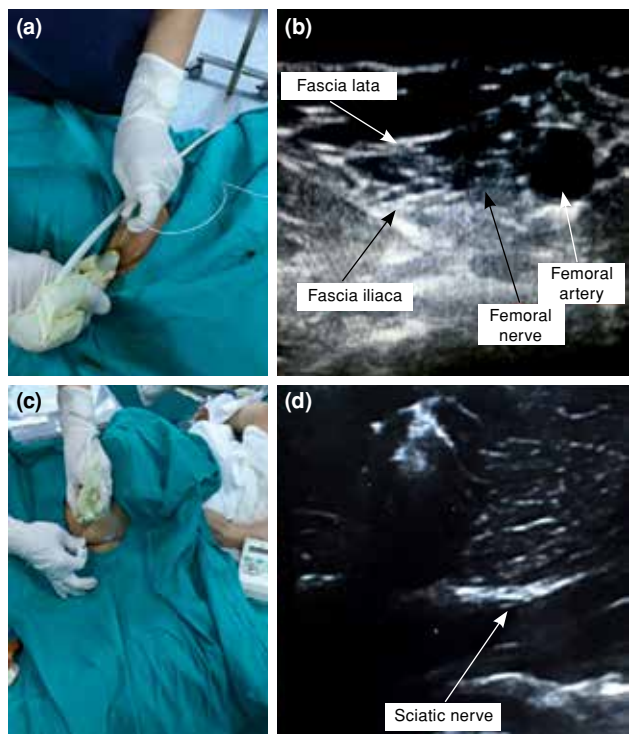

Figure 1. (a, b) Ultrasound-guided femoral nerve block. **(c, d)** Ultrasound-guided sciatic nerve block.

as 1 or 2 according to the criteria of American Society of Anesthesiologists. The study protocol was approved by the University of Health Sciences, Dr. Abdurrahman Yurtaslan Ankara Oncology Training and Research Hospital Ethics Committee (2013/342). A written informed consent was obtained from parents of all patients. The study was conducted in accordance with the principles of the Declaration of Helsinki.

All the patient data concerning this manuscript were provided from our hospitals' anesthesiology and reanimation clinical archive. All patients were parenterally administered midazolam 0.01 mg/kg for premedication. After the patient was taken to operation room; heart rate, systolic arterial pressure, diastolic arterial pressure, mean arterial pressure, and peripheral oxygen saturation values were monitored by non-invasive methods. Oxygen (100%) was administered for three minutes for pre-oxygenation, and then propofol 2-3 mg/kg and fentanyl 1 μg/kg parenterally were administered. Intubation was performed after muscle relaxation using rocuronium bromide 0.5 mg/kg. Anesthesia was maintained by oxygen 33%, nitrous oxide 67%, and sevoflurane (Minimal Alveolar Concentration [MAC]:2)

After termination of the operation, neuromuscular blocks of patients were reversed, peripheral nerve block compatible with the surgery site was performed with US guidance and nerve stimulator (Figure 1). For peripheral nerve block, a proper body position was obtained. Skin was cleaned and covered. Axial image of the nerve was obtained by 10-18 MHz linear probe (Esaote MyLab Five, Genova, Italy) of ultrasonography based on surgery site. By using in-plane method, isolated stimulator needle (Contiplex S Ultra, 18G, Stimuplex D.B. Braun Medical-Freiburg, Germany) was inserted. The location was confirmed by peripheral nerve stimulator (0.5 mA current), while intravascular injection was eliminated by aspiration. Bupivacaine (0.25%) dose was adjusted to 0.1-0.2 mL/kg for upper extremity and 0.3-0.4 mL/kg for lower extremity. Injection of local anesthetic drug was performed after intermittent negative aspiration test and surrounded the nerve. The block types applied according to the disease operation types are shown in Table I. Children without block were given acetaminophen 15 mg/kg parenterally. The patients were extubated after peripheral nerve blocks.

Pain scores were recorded after peripheral nerve blocks immediately postoperatively, and at postoperative first, second, sixth, and 24th hours by

TABLE I

Blocks according to operation type

Block type (block percentage)	n	%	Operation type
Femoral nerve block	10	25.9	Osteosarcoma surrounding knee
	4		Soft tissue tumor
Sciatic nerve block	2		Chondromyxoid fibroma of tibia
	2	14.8	Giant cell tumor of proximal tibia
	4		Operated tumor revision of tibia
Axillary nerve block	3		Synovial sarcoma
	2	11.1	Ewing's sarcoma
	1		Phalanx enchondroma
Supra or infraclavicular nerve block	2		Forearm aneurismal bone cyst
	2		Arm soft tissue tumor
	4	25.9	Humeral Ewing's sarcoma
	2		Humeral osteosarcoma
	2		Elbow tumor mass
	2		Humeral proximal pathological fracture (aneurismal bone cyst)
Interscalene nerve block	2		Shoulder desmoid tumor
	2		Shoulder rhabdomyosarcoma
	2	10	Humeral proximal exocytosis
	2		Humeral chondrosarcoma
	2		Humeral cyst excision
Femoral + sciatic nerve block	2	3.7	Thigh angiosarcoma

TABLE II

General characteristics of patients

	Group 1		Group 1	
	%	Mean±SD	%	Mean±SD
Age (year)		9.6±0.38		10.9±0.4
Weight		44±1.7		40.4±0.32
Gender				
Girl	21.29		19.44	
Boy	30.55		28.73	

SD: Standard deviation.

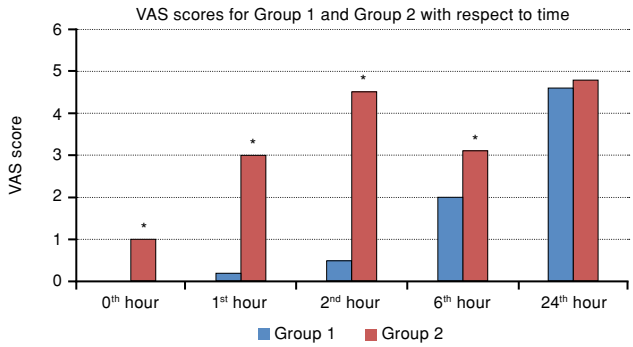

Figure 2. Postoperative visual analog scale scores of groups respective to hours.

VAS: Visual analog scale; *: Statistically significant difference between groups ($p<0.05$).

visual analog scale (VAS). Possible complications (neuropraxia and hematoma, etc.) were also recorded. The pain onset point was accepted as the VAS score above 3 and the first time of analgesic need. Patients with a VAS score higher than 3 were given analgesic drugs based on current protocols (tramadol 1 mg/kg parenterally). The intensity of pain in little children was decided by their crying, facial expression, condition of extremities, body movements, and patients' comments about their children. Complications such as vomiting or nausea and total analgesic consumption in postoperative 24 hours were also evaluated.

Statistical analysis

Comparison of VAS scores in each block type was performed by Wilcoxon signed rank test. Visual analog scale rates between groups 1 and 2 were compared by chi-square test. When the type of block was taken as the variable, comparison of VAS scores immediately postoperatively, and at postoperative first, second, sixth, and 24th hours were performed by Kruskal-Wallis test. The severity of vomiting, nausea, and total analgesic consumption were compared by using chi-square test. Statistical significance level was adjusted to $p<0.05$.

RESULTS

There was no difference in general characteristics of patients between the groups ($p>0.05$, Table II). Visual analog scale scores were higher in group 2 than group 1 immediately postoperatively, and at postoperative first, second, and sixth hours ($p<0.05$), while there was no difference between groups at 24th hour (Figure 2).

Within group 2, VAS scores were significantly higher at 24th hour (4.9) compared to immediately postoperatively, and at postoperative first, second, and sixth hours (1, 3, 4.6, 3.1, respectively). Since

TABLE III

Groups and mean time to pain onset, frequency of nausea, vomiting, and total analgesic consumption in 24 hours

Group 1 block types	Time to pain onset (hour)	Patients with nausea or vomiting	Total analgesic consumption in 24 hours (mg/kg)
	Mean±SD	x/n	*p*
Femoral nerve block	11.07±6.3	3/14	-
Sciatic nerve block	12.80±8.15	2/8	-
Axillary nerve block	9.3±1.52	0/6	-
Supraclavicular nerve block	8.35±5.98	3/14	-
Interscalene nerve block	9.90±8.29	2/10	-
Femoral + sciatic nerve block	12.8±8.15	0/2	-
Group 1	10.2±6.4*	10/54	0.07**
Group 2 (Intravenous drug treatment)	1.8±0.3*	9/54	1.7**

SD: Standard deviation; x/n: Patients with nausea or vomiting/total number of patients; * Difference between two groups in time to pain onset, $p<0.05$; ** Difference between two groups in total analgesic consumption, $p<0.05$.

the mean VAS value was above 3 at second hour, analgesic was added in group 2. As a result, the mean VAS score at sixth hour was lower than the second hour (3.1 and 4.6, respectively) in group 2. The mean VAS score at 24th hour (4.7) was also higher than that of the first, second, and sixth hours (0.2, 0.5, 2, respectively) ($p<0.001$) in group 1 (Figure 2). These results suggest that nerve blocks were more efficient during the first six hours compared to following time points.

We also compared the mean VAS scores among the different block types. There was no significant difference among the VAS scores of time points at first, second, sixth, and 24th hours ($p<0.05$). The mean time to pain onset was 10.2±6.4 hours in group 1 and 1.8±0.3 hours in group 2 ($p<0.05$). Mean time to pain onset and VAS values at first, second, sixth, and 24th hours did not differ between nerve block types (Table III).

Of the 54 patients in each group, 10 (18.5%) had postoperative nausea and vomiting in group 1 versus nine (16.7%) in group 2, with no statistical difference between two groups ($p=0.417$).

The analgesic requirement in group 1 occurred later than six hours and the total analgesic consumption in 24 hours was significantly lower than that of group 2 ($p<0.05$) (0.07 and 1.7 mg/kg, respectively) (Table III).

DISCUSSION

In our study, we showed that the peripheral nerve block applied in pediatric patients under general anesthesia enhanced and prolonged postoperative analgesia and reduced the analgesic consumption of patients without significant side effects.

A total of 40,121 peripheral nerve blocks were analyzed in the USA in a study on pediatric population. In this study, the local anesthetics dosage ranged up to 10 times of the regular dose according to the block types in various operations. Two patients developed local anesthetic systemic toxicity with an estimated incidence of 0.005% per block (0.001-0.015%, 95% confidence interval). None of the patients had any short- or long-term complications or sequelae. No standard local anesthetic dosage for peripheral nerve blocks in children was recorded in most hospitals. Due to the low number of peripheral nerve block studies, there is a need to develop application guidelines to minimize the variability of regional anesthesia practices in children.[8]

Marinković et al.[6] applied lower extremity nerve block in pediatric patients who underwent knee arthroscopy. They examined the need for intra- and postoperative VAS scores and analgesic requirement. Similar to our study, VAS scores and analgesic consumption were lower in the block group. They have not encountered any complications. In regional anesthesia, side effects of opioid analgesia such as vomiting, nausea, itching, tinnitus, and prolonged sedation were not recorded. Turner et al.[7] performed postoperative pain assessment in femoral nerve block pediatric patients with femoral fractures. In the block group, they obtained long-term analgesia and found that postoperative drug consumption decreased significantly.

Moreover, Wathen et al.[8] found that US-guided fascia iliaca compartment block was superior to intravenous morphine treatment for postoperative analgesia in children with femoral fracture. In the group with block, the average first analgesic requirement time was at postoperative sixth hour. In our study, we observed that various US-guided peripheral nerve blocks were effective in preventing postoperative pain. The mean time to pain onset was 10.2 hours and there was no difference among the block types. Additional doses of analgesics were not required.

Ultrasound guidance in peripheral nerve blocks may reduce the volume and toxicity of local anesthetics. Oberndorfer et al.[9] compared US-guided and neurostimulator assisted femoral nerve blocks and found that US-guided group required less amounts of drug with longer time of anesthesia. Various other studies also demonstrated the benefits of US guidance in peripheral nerve blocks.[8-11] In our study, all blocks were performed with US guidance and none of the blocks was failed.

Jagannathan et al.[11] performed single-dose caudal block under anesthesia for postoperative pain management following inguinal hernia, hydrocele repair, and orchiopexy in 50 pediatric patients aged between 1 to 6 years. Patients were divided into two groups and one group had ilioinguinal block in addition to caudal block whereas the other group only had caudal block. The mean time to first analgesic need was 171 minutes in caudal block group whereas it was 272 minutes in caudal block plus ilioinguinal block group. The difference was statistically significant. However, the difference varied according to the type of surgical procedure. In our study, time to first pain episode was 10.2 hours and was not dependent on surgical procedure and thus block type. Time

to first analgesic need was longer in our study compared to the study of Jagannathan et al.[11] This may be due to the concentration of bupivacaine (0.250% vs. 0.125%, respectively).

Furthermore, Willschke et al.[12] compared conventional "fascial click" method and US-guided ilioinguinal/iliohypogastric block after anesthesia induction by using mask in 100 children (age range, 1 month to 8 years) who underwent inguinal hernia repair, orchiopexy, or hydrocele repair. They demonstrated that US-guided peripheral nerve blocks increased the success rate and reduced drug volume and complications. Blind and US-guided ilioinguinal blocks were compared and anatomic visualization by US prolonged duration of analgesia and reduced pain scores.[13] Ultrasound guidance in these blocks reduced the block application time and volume of local anesthetic drug. Reduction of the volume of the drug reduces the likelihood of complications. We performed US-guided peripheral nerve block with nerve stimulator under general anesthesia and experienced no failure of any block or block-related problem. Of the 54 patients, 10 had postoperative nausea and vomiting in block group while nine had postoperative nausea and vomiting in analgesic treatment group. These may be related to general anesthesia, time spent in intensive care after surgery or chemotherapy in patients with a malignancy. There was no sign of local anesthetic toxicity or block-related side effects.

Peripheral nerve blockade can also be a useful component of a multimodal analgesia approach in pain management after knee arthroscopy. In a prospective, observational study on pediatric patients who underwent arthroscopic anterior crucial ligament reconstruction (ACL) and/or meniscus procedures with peripheral nerve blocks, short-term patient outcomes and side effects for 72 hours following discharge were evaluated. Regional nerve block was found to be an effective and safe analgesic strategy for pediatric arthroscopic ACL and meniscus procedures, with no short-term complications or readmissions related to pain.[14]

Our study has several limitations. One of them is its retrospective design. Another limitation is the difficulty in objective pain evaluation in younger children. However, these pediatric oncology patients mostly spent a long time in hospital and experienced many painful conditions. Thus, information taken from their family members and hospital staff was considered to be reliable.

In conclusion, US-guided peripheral nerve blocks can be safely performed in pediatric patients following orthopedic tumor surgery before the general anesthesia is terminated. Such blocks decreased postoperative pain and analgesic requirement. Thus, we recommend the application of US-guided peripheral nerve blocks in pediatric orthopedic tumor surgery.

Declaration of conflicting interests

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