Searching the Effects of Applying Caudal Block or I.V. Tramadol on Bispectral Index, Emergence Agitation and Recovery in Children Under Desflurane Anesthesia

Çocuklarda Desfluran Anestezisi Altında Kaudal Blok veya İ.V. Tramadol Uygulamasının Bispektral İndeks, Erken Ajitasyon ve Derlenme Üzerine Etkilerinin Araştırılması

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ABSTRACT Objective: We aimed to compare applying caudal block and i.v. tramadol about their effects on bispectral index (BIS), emergence agitation (EA) and recovery in children under desflurane anesthesia. **Material and Methods:** 60 children, aged between 2-10 years old, ASA I-II groups, undergoing elective lower abdominal surgery enrolled in the study and randomly divided into two groups. Anesthesia was induced with 6-8% sevoflurane in nitrous oxide/oxygen (50%, 50%) and desflurane was used in the maintenance. Group 1 patients had a caudal block by applying 0.25% bupivacaine in a dose of 0.5 mL kg^{-1}. Group 2 patients received i.v. tramadol 1 mg kg^{-1}. BIS monitoring was applied in each group. Haemodynamic parameters, the concentrations of sevoflurane, desflurane, end tidal sevoflurane, end tidal desflurane and BIS values were recorded. Cases were assessed about EA, recovery and pain. **Results:** Systolic and diastolic blood pressures, heart rates were decreased in Group 1 after caudal block application. Desflurane and end tidal desflurane concentrations were lower in Group 1 than Group 2 at 15, 30, 45, 60th min after incision and at the end of surgery ($p<0.05$). BIS values and EA scores were similar between groups ($p>0.05$). There was statistically no difference between groups about recovery and pain ($p>0.05$). **Conclusion:** It was concluded that in children under desflurane anesthesia; similar anesthesia depth and well recovery could be achieved by applying both caudal block and i.v. tramadol and the level of EA were similar in both of these methods.

Key Words: Desflurane; anesthesia, caudal; tramadol; anesthesia recovery period

ÖZET Amaç: Çalışmamızda çocuklarda desfluran anestezisi altında kaudal blok ve i.v. tramadol uygulamasını; bispektral indeks (BİS), erken ajitasyon (EA) ve derlenme üzerine etkileri açısından karşılaştırmayı amaçladık. **Gereç ve Yöntemler:** Elektif alt batın cerrahisi operasyonu uygulanacak ASA I-II grubu, 2-10 yaşları arasında 60 hasta çalışma kapsamına alınarak rastgele 2 gruba ayrıldı. Anestezi indüksiyonu %6-8 konsantrasyonda sevofluran, %50 azot protoksit ve %50 oksijen karışımı ile sağlanırken idamede desfluran kullanıldı. Grup 1 hastalara %0,25 bupivakain 0,5 mL kg^{-1} dozda uygulanarak kaudal blok gerçekleştirildi. Grup 2 hastalara i.v. 1 mg kg^{-1} tramadol uygulandı. Her 2 grupta da BİS monitörizasyonu yapıldı. Olguların hemodinamik parametreleri, sevofluran, desfluran, end tidal sevofluran ve end tidal desfluran konsantrasyonları, BİS değerleri kaydedildi. Olgular EA, derlenme ve ağrı açısından değerlendirildi. **Bulgular:** Yapılan ölçümlerde sistolik kan basıncı, diyastolik kan basıncı, kalp atım hızı değerlerinin Grup 1'de kaudal blok uygulaması sonrası düştüğü gözlendi. Cilt insizyonu sonrası 15. dk, 30. dk, 45. dk, 60. dakikalardaki ve cerrahi bitimindeki desfluran ve end tidal desfluran konsantrasyonları Grup 1'de Grup 2'den daha düşük bulundu ($p<0,05$). BİS ve EA değerleri gruplar arasında benzerdi ($p>0,05$). Derlenme ve ağrı değerleri bakımından gruplar arasında istatistiksel açıdan fark saptanmadı ($p>0,05$). **Sonuç:** Çocuklarda desfluran anestezisi altında hem kaudal blok uygulaması hem de i.v. tramadol uygulamasıyla yeterli anestezi derinliği ve iyi bir derlenme sağlanacağı; her iki yöntemin de erken ajitasyonu etkin postoperatif analjezi sağlama yoluyla azaltabileceği kanısına varıldı.

Anahtar Kelimeler: Desfluran; anestezi, kaudal; tramadol; anestezi toparlanma dönemi

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The newer volatile anesthetics, sevoflurane and desflurane, have gained increasing acceptance because of their low blood-gas and blood- tissue solubility, leading to increased control and rapid recovery after general anesthesia.[1,2] Sevoflurane is an appropriate volatile anesthetic for mask induction because of its favorable smell and because it is nonirritating. Desflurane seems to be inappropriate for mask induction, as it may provoke complications during inhaled induction in children resulting in breath holding, laryngospasm, and coughing.[2] Despite this disadvantage, maintenance and emergence of anesthesia with desflurane are not associated with an increased risk of respiratory complications.[3]

The increased use of sevoflurane and desflurane in children is associated with the increase of postoperative behavioural change Emergence Agitation (EA).

First described in the early 1960s, EA is a clinical condition in children experience a variety of behavioral disturbances, including crying, sobbing, thrashing, and disorientation, during early emergence from anesthesia.[4]

EA often requires treatment with additional analgesics or sedatives in these children. The use of these medications and the need for additional observation prolongs and complicates postanesthesia care and may delay discharge.[5]

Possible causes include pain, preoperative anxiety, type of surgical procedures, personal characteristics of the patient, and type of anesthetics, although no sole factor can explain the ethyology of EA.[6]

Bispectral Index (BIS), is an electro-ensephalographic parameter improved to evaluate the hypnotic effects of anesthetic and sedative drugs. The level of the sedation and hypnose can be watched on the BIS monitor as a numerical value from 0 to 100 by the help of a sensor placed into the fronto-temporal region. Scale from 81 to 100 reflects awakeness, 61 to 80 little sedation, 41 to 60 mid hypnotic level, 40 and below deep hypnotic level.[7]

The primary aim of this study was to compare caudal block and i.v. tramadol on the effects of BIS, EA and recovery under desflurane anesthesia.

MATERIAL AND METHODS

After approval by the Ethics Commitee and written informed consent of all parents, 60 children aged between 2 and 10 years old, ASA I-II groups, undergoing elective lower abdominal surgery (hypospadias repair, inguinal hernia repair, orchiectomy, hydroco electomy etc.) were enrolled. Patients were excluded if they had contraindication for caudal epidural analgesia (systemic or local infection, allergy to local anaesthetics, deformity with vertebral column, coagulation disorders, neurological disorders), failed caudal block, serious heart, lung, liver and kidney sufficiency.

Patients were admitted to the preoperative room with their parents 30 minutes before the surgery. No premedication was administered preoperatively. The 60 patient were randomly divided into two groups. Group 1 patients who are being applied caudal block and Group 2 patients being applied i.v. tramadol for postoperative analgesia.

Patients were admitted to the operation room with one of their parents, routine monitoring with electrodes for electrocardiography, non invasive blood pressure, pulse oximeter were applied. BIS was applied after intubation. For BIS monitoring the skin was cleaned with alcohol and got dried. The BIS sensor was placed on the forehead and temple using a frontal-temporal montage, pressed for 5 seconds, and skin-sensor connection was established.

Anesthesia was induced with 8% sevoflurane in nitrous oxide/oxygen (50%/50%) and maintained with desflurane in the same N2O/O2 concentrations. After intravenous cannulation vecuronium bromide in the dose of 0.1 mg kg-1 was used for neuromuscular blockage. Trachea was intubated easily with suitable tracheal tube. After intubation of trachea, lungs were ventilated with pressure -controlled ventilation to maintain end-tidal carbondioxide concentration (ETCO2) at 30-35 mmHg and inspiratuar airway pressure (Pinsp) below 20 mmHg (Drager-Primus). Maintenance of the anesthesia was achieved with 4-6% desflurane in nitrous oxide/oxygen (50%/50%) concentrations with the flow 4 L min-1 and peripheral oxygen saturation 97-100%. For the maintenance of

neuromusculer blockage intermittant doses of vecuronium bromide (0.025 mg kg-1) was used.

Group 1 patients had a caudal block by positioning in lateral decubitis position and applying 0.25% bupivacaine in a dose of 0.5 mL kg-1. Group 2 patients received i.v. tramadol 1 mg kg-1. BIS monitoring was applied in each group.

Measures of systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR), peripheral oxygen saturation (SpO2), the concentrations of sevoflurane, desflurane, end tidal sevoflurane (ETsevo), end tidal desflurane (ETdes) and BIS values were recorded. Records concluded the time periods; before induction, after induction, after intubation, 2 min before incision, incision, 2, 5, 15, 30, 45, 60 min after incision, end of surgery, awakeness after extubation.

The titration of anesthetics was adjusted by the haemodynamic responses during operation. The concentrations of anesthetics was adjusted to keep haemodynamic variables within 20% of baseline values. BIS was recorded by the anesthesia helper, independent from the anesthetist by the values on the monitor at the time without achieving in certain ranges.

At the end of surgery anesthesia was discontinued. Neuromusculer blockage was reversed in both groups with neostigmine (0,05 mg kg-1) and atropine sulphate (0,015 mg kg-1) i.v. After achieving adequate spontaneous breathing and airway responses, patients were extubated. Operation time (time from the skin incision to the end of the operation), anesthesia time (time from the induction of the anesthesia to discontinued the anesthetic drugs), nausea, vomiting, laringospasm and other side effects, eye opening, time to transfering to post anesthesia care unit (PACU) were recorded. Parents were reunited with their children in the PACU after an initial admisssion and stabilisation phase.

Cases were assessed about EA, recovery and pain. The time interval to record them was awakeness, arrival to the PACU within the minutes of 0, 10, 20, 30. Pediatric Anesthesia Delirium (PAED) Scale was used to assess EA, Modified Aldrete Recovery Score was used to assess recovery, FLACC Behavioral Assessment Pain (FLACC) Scale was used to assess pain.

Fentanyl 1 mcg/kg i.v. was applied if the fourth and fifth items in the PAED Scale were 3 and 4 (Table 1) and if pain was 5 and over for the FLACC Scale (Table 2).

The data were analyzed using SPSS 18.0 software. Categorical variables were expressed as numbers and percentages, continuous variables were expressed as mean and standard deviation (as median and minimum-maximum where necessary). Chi squared test was used to compare the categorical variables between groups. About comparision of continuous variables between groups, t-test or Mann Whitney U test was used if the assumptions were provided or not. Repeated Measurements analysis was used to compare the change in time of

TABLE 1: Pediatric anesthesia emergence delirium (PAED) scale

	Score	
1.The child makes eye contact with the caregiver	4=not at all	1=very much
2.The child's actions are purposeful	3=just a little	0=extremely
3.The child is aware of his/her surroundings	2=quite a bit	
4.The child is restless	0=not at all	3=very much
5.The child is inconsolable	1=just a little	4=extremely
	2=quite a bit	

TABLE 2: FLACC behavioral assessment pain scale.

Face	0-No particular expression or smile 1-Occasional grimace or frown; withdrawn, disinterested 2-Frequent to constant frown, clenched jaw, quivering chin
Legs	0-Normal position or relaxed 1-Uneasy restless, tense 2- Kicking or legs drawn up
Activity	0-Lying quietly, normal position, moves easily 1-Squirming, shifting back and forth, tense 2-Arched, rigid, or jerking
Cry	0-No cry (awake or asleep) 1-Moans or whimpers, occasional complaint 2-Crying steadily, screams or sobs; frequent complaints
Consolability	0-Content, relaxed 1-Reassured by occasional touching, hugging or being talked to; distractable 2-Difficult to console or comfort

continuous variables performed on the same individuals at different times. A *p* value less than 0.05 was considered statistically significant.

RESULTS

The groups were similar with regard to age, sex, weight, operation time and anesthesia time (Table 3).

Systolic and diastolic blood pressures, heart rates were decreased in Group 1 after caudal block application (Figure 1, 2, 3).

Desflurane and end tidal desflurane concentrations were significantly lower in Group 1 at 15, 30, 45, 60 min after incision and at the end of operation ($p<0.05$) (Table 4).

BIS values were similar between groups except 45 min after incision. In Group 1, BIS value was significiantly higher at 45 min after incision ($p<0.05$) (Figure 4). BIS value at 45 min after incision might be increased in group 1 as a result of anesthetic concentrations were decreased by the effect of caudal block.

TABLE 3: Demographic data of the groups (mean±SD).

	Group 1	Group 2
Age (year)	5,07±2,82	5,71±2,64
Sex (boy/girl)	29/1	28/2
Weight (kg)	17,75±5,67	20,26±7,30
Operation time	86,63±46,69	67,10±25,07
Anesthesia time	103,93±49,24	78,90±25,51

Emergence agitation scores were similar between groups except 10 min after arrival to PACU. In Group 2 emergence agitation score was

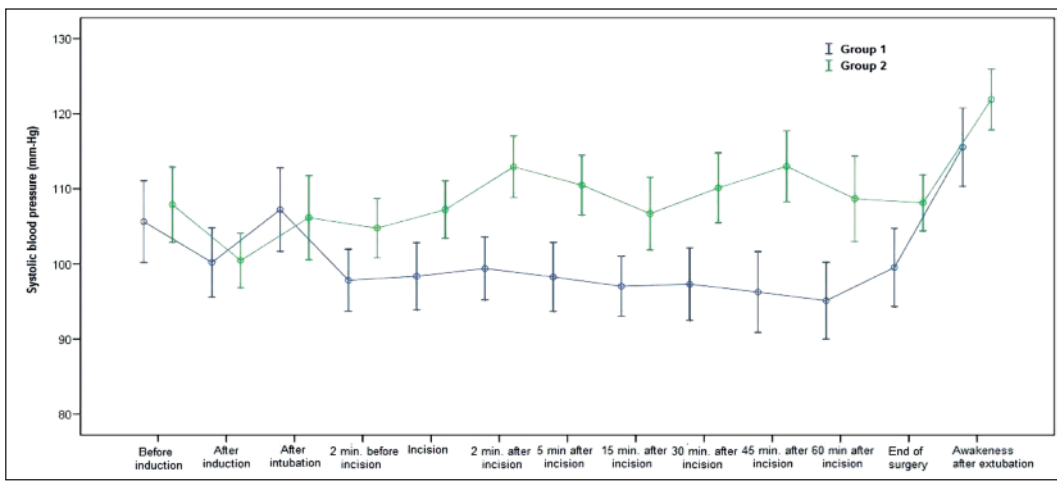

FIGURE 1: Systolic blood pressure-time scale.

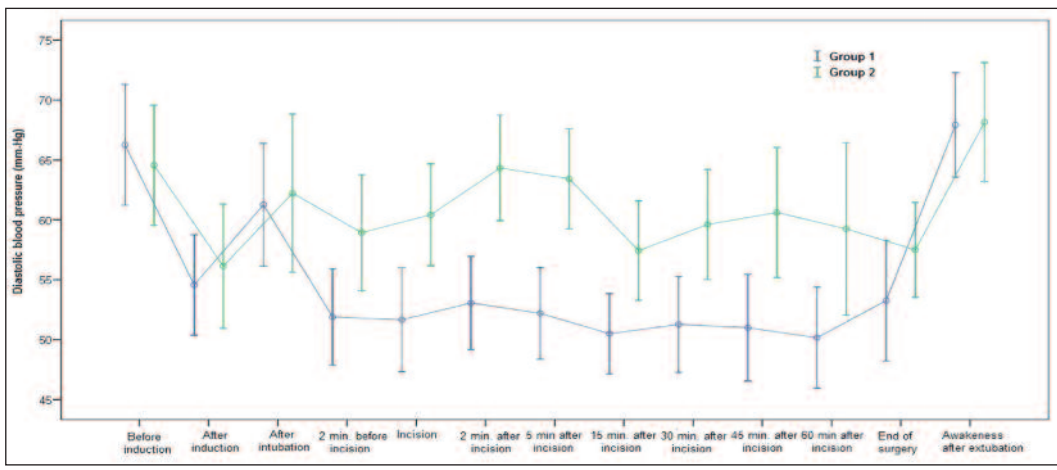

FIGURE 2: Diastolic blood pressure-time scale.

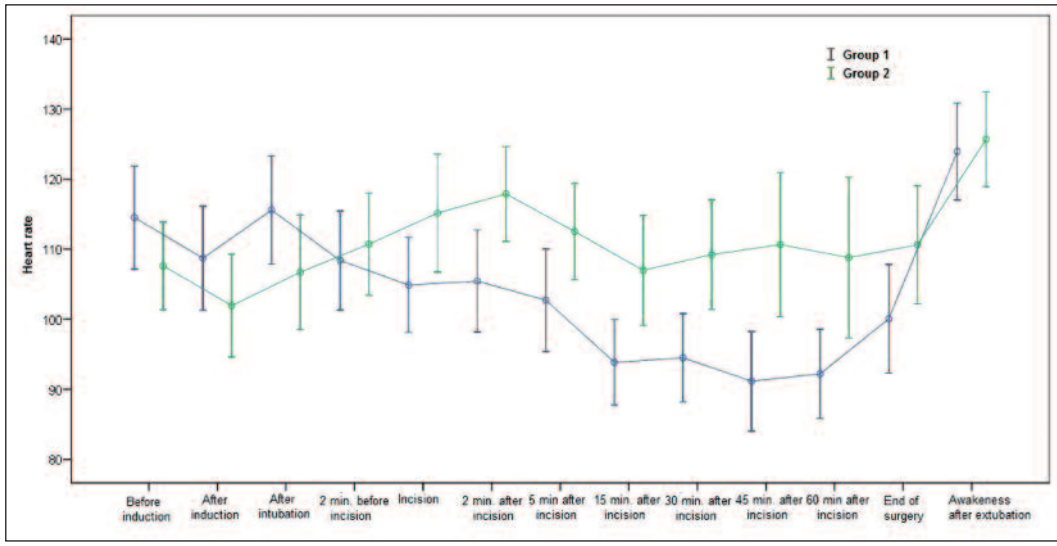

FIGURE 3: Heart rate-time scale.

significiantly higher at 10 min after arrival to PACU ($p<0.05$) (Figure 5).

There was statistically no difference between groups about transfer time to PACU, time of eye opening, recovery and pain ($p>0.05$) (Table 5, 6, 7). No cough, breath holding, laringospasm was seen. Two patients had nausea and 5 patients had vomiting in group 1; 4 patients had nausea and 5 patients had vomiting in group 2. No urinary retension was seen.

In Group 2, two patients received fentanyl 1 mcg kg-1. There was no treatment with fentanyl in Group 1.

TABLE 4: End-tidal desflurane concentration (mean±SD).

End-tidal desfluran	Group 1	Group 2	p
After intubation	4,59±0,46	4,23±1,07	0,100
2 min before incision	4,99±0,49	4,68±0,76	0,074
Incision	4,93±0,58	4,88±0,58	0,742
2 min after incision	4,94±0,52	4,98±0,56	0,759
5 min after incision	4,85±0,64	5,11±0,61	0,123
15 min after incision	4,66±0,67	5,27±0,57	<0,001
30 min after incision	4,49±0,89	5,34±0,61	<0,001
45 min after incision	4,36±0,83	5,23±0,77	0,001
60 min after incision	4,37±0,80	5,11±0,98	0,023
End of surgery	2,44±1,52	3,54±1,52	0,007

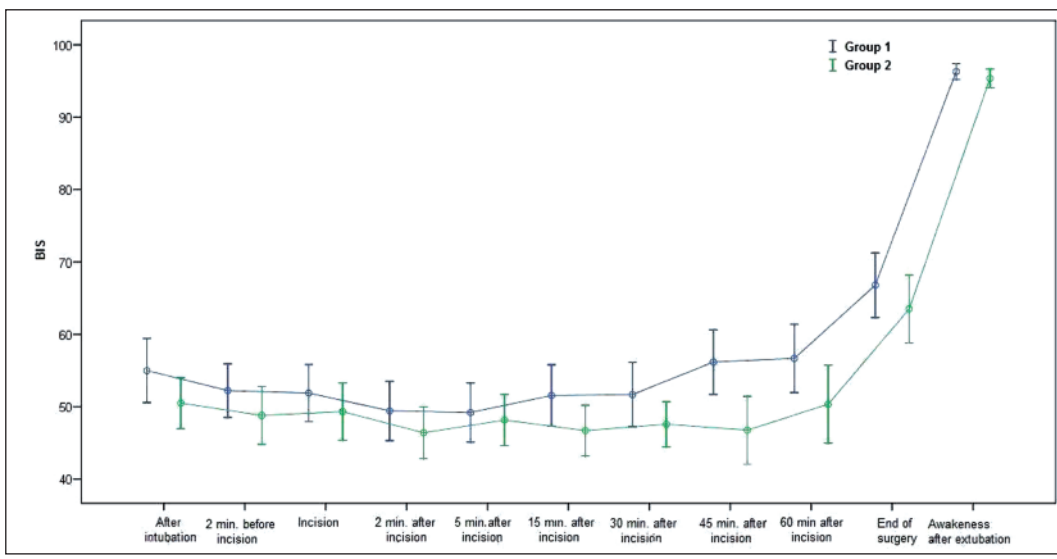

FIGURE 4: BIS values of groups in time.

DISCUSSION

The relatively high incidence of EA in children after general anesthesia with sevoflurane or desflurane has been well described.[5,8] The underlying mechanism is not clear but the proposed causes of EA observed with desflurane and sevoflurane include rapid emergence, variable neurological recovery and increased pain sensation.[9-11]

BIS is used to measure the sedation and hypnose level of i.v. anaesthetics, sedatives and potent volatile anesthetics. It is put forward that for monitoring the depth of anesthesia by this method can be used as an alternative to clinical parameters as haemodynamic variables, tears, sweating, pupil size.[12]

In our study applying caudal block and i.v. tramadol to children undergoing lower abdominal surgery were compared about the effects on BIS, EA and recovery.

BIS monitoring was used to assess the depth of anesthesia. The titration of anesthetics was set to haemodynamic responses not to BIS value. The BIS values seen on the monitor were recorded. About the BIS value there was no statistically significant difference between the groups except 45 min after incision. The BIS value 45 min after incision was higher in the group caudal block applied.

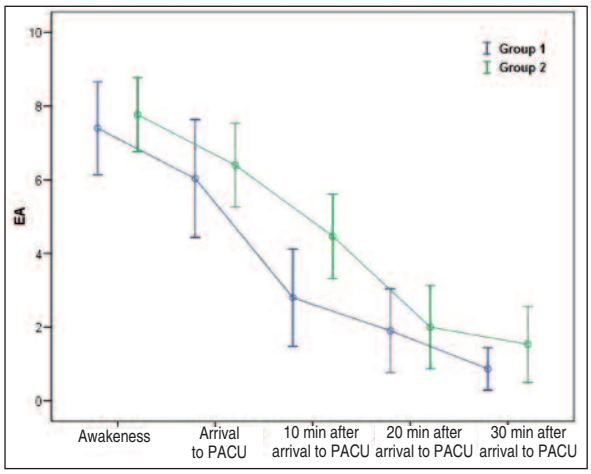

FIGURE 5: Emergence agitation scores of groups in time.

TABLE 5: Times of transfer to PACU and eye opening of the groups (mean±SD).

	Group 1	Group 2	P
Transfer to PACU	4,87±0,93	5,27±1,14	0,144
	5,00 (3-7)	5,00 (4-8)	
Eye opening	2,87±0,97	2,83±1,14	0,904
	3,00 (1-5)	2,00 (1-5)	

TABLE 6: Scores of pain (mean±SD).

Pain	Group 1	Group 2	p
Awakeness	4,27±2,42	3,50±2,51	0,278
	4,00(0-8)	4,00(0-10)	
Arrival to PACU	3,67±3,15	3,57±3,10	0,910
	3,50(0-10)	3,00(0-10)	
10 min after arrival to PACU	1,53±2,17	2,57±2,75	0,102
	0,00(0-7)	2,00(0-10)	
20 min after arrival to PACU	1,03±1,73	0,83±1,70	0,696
	0,00(0-6)	0,00(0-6)	
30 min after arrival to PACU	0,50±1,07	0,57±1,16	0,797
	0,00(0-3)	0,00(0-4)	

TABLE 7: Scores of recovery (mean±SD).

Derlenme	Group 1	Group 2	p
Awakeness	8,70±1,23	8,20±1,18	0,115
	9,00(5-10)	8,00(6-10)	
Arrival to PACU	9,57±0,77	9,60±0,67	0,859
	10,00(7-10)	10,00(7-10)	
10 min after arrival to PACU	9,70±0,70	9,77±0,62	0,699
	10,00(7-10)	10,00(7-10)	
20 min after arrival to PACU	9,83±0,37	9,90±0,30	0,456
	10,00(9-10)	10,00(9-10)	
30 min after arrival to PACU	9,87±0,34	9,90±0,30	0,694
	10,00(9-10)	10,00(9-10)	

Punjasawadwong et al. reported that emergence from anesthesia is more faster if depth of anesthesia is maintained by BIS value between 40 and 60 min.[13]

In our study desflurane concentrations in the caudal group were lower than tramadol group and BIS values were between 40 and 60 min during operation time. It was observed that; similar BIS values was maintained by higher concentrations of desflurane in the tramadol group.

Studies have shown that preemptive analgesic approach reduces the emergence agitation as pain is the main source of EA.[14]

Aouad et al. investigated the effect of preoperative caudal analgesia on the incidence and severity of emergence agitation on 48 children aged 2-6 years undergoing inguinal hernia repair.

Children were assigned to one of two groups: children in the caudal group received a caudal block to supplement sevoflurane, while children in the fentanyl group received i.v. fentanyl before incision. Groups were compared about EA and pain. They reported that children assigned to receive a caudal block preoperatively were significiantly less agitated following anesthesia and had significantly lower median pain scores.[15]

Fan et al. reported in 40 children aged 1-8 years undergoing inguinal operation under sevoflurane anesthesia that i.v. tramadol 1 mcg/kg given before the end of operation reduces the postoperative pain and the incidence and degree of EA.[16]

In our study there was no statistically significiant difference between caudal block group and tramadol group about pain scores. Effective postoperative analgesia was achieved by applying caudal block or i.v. tramadol.

Peak emergence agitation score was found 7,5 (0-14) in caudal block group and it was 8 (1-13) in the tramadol group. As in the PAED scale EA score differs between 0 and 20 it can be said in our study that EA scores are low in each gro-up.

It is reported that by preoperative caudal analgesia the anesthetic requirements can be reduced.[17] In our study desflurane concentrations in the caudal block were lower than concentrations in the tramadol group so consumption of desflurane was lower as well.

Erol et al. reported in their study that caudal block aplication added to general anesthesia in children represses the haemodynamic responses to the stress of surgery.[18] We observed reduction in systolic blood pressure, diastolic blood pressure and heart rate compared to the preoperative measurements after applying caudal block.

In our study there was no statistically significiant difference between the groups about recovery. Maximum score in Modified Aldrete Recovery Score is 10. Recovery scores measured after awakening in our study was quite high as [9 (5-10)] in caudal block group and as [8 (6-10)] in the tramadol group. Full scores was achieved in the PACU.

CONCLUSION

In our study applying caudal block and i.v. tramadol was compared on the effects of BIS, EA and recovery in children under desflurane anesthesia.

It was concluded that similar anesthesia depth and well recovery can be provided by applying both caudal block and i.v. tramadol in children under desflurane anesthesia and both of them effects EA similarly.

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