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Dexmedetomidine Versus Fentanyl in Caudal Block for Postoperative Pain Relief in Pediatric Surgery

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ABSTRACT

Background: Caudal block is one of the most common regional anesthetic techniques used in children. It is considered safe and simple procedure but its main disadvantage is its relatively short duration of action even with use of long acting agents such as bupivacaine. Fentanyl is most common additive to local anesthetics to caudal block, but it has undesirable side effects. Dexmedetomidine is α_2 adrenergic receptor agonist which prolongs the duration of analgesia when added to caudal bupivacaine.

Objective: This work aimed to compare the postoperative analgesic and any side effects of addition of either dexmedetomidine or fentanyl to bupivacaine in pediatric patients undergoing lower abdominal and lower limb surgeries.

Patients and methods: This interventional randomized-controlled study was carried out in Department of Anesthesia and Intensive Care, Sohag University Hospital. Sixty patients aged from 2 to 6 years who were going to do a lower abdominal surgery were included in the study.

Results: As regards sedation score, dexmetedomidine showed more sedation than that of fentanyl where there was a significant difference between both groups at ½ hour and 1 hour (P value 0.008 and 0.016 respectively) and number of children sedated in group D (23) was more than that of group F (8) at 1 hour.

Conclusion: Adding dexmetedomidine to bupivacaine in caudal block is longer in duration of postoperative analgesia and showed more sedation time than that of fentanyl with more stability in haemodynamics.

Keywords: Dexmedetomidine, Fentanyl, Caudal block analgesia, Pediatric surgery.

INTRODUCTION

Pain is an unpleasant subjective sensation, which can only be experienced and not expressed, especially in children [(1)]. Acute pain management for surgical patients intraoperatively and post operatively is important for the patient comfort. It leads to an improved perioperative experience and reduction in pulmonary complications [(2)]. This result in reduced hospital costs due to short hospital stay especially in ambulatory surgical patient [(3, 4)].

The concept of postoperative pain relief and its utilization in children has improved dramatically over the recent years. Till date, many methods have evolved for providing postoperative pain relief in pediatric population, nonetheless having some side effects, which prohibit their use in children [(1)].

Caudal block is one of the most popular regional techniques in pediatrics and is commonly used for procedures below umbilicus including urogenital, rectal, inguinal and lower extremities surgery. Single shot caudal epidural blockade is one of the most widespread techniques providing intra- and pos-toperative analgesia in pediatric patients [(5)]. Pediatric caudal blocks were performed after the induction of general anesthesia. This technique (block) is useful adjunct during general anesthesia and for providing postoperative analgesia. The quality and level of caudal blockade is dependent on the dose, volume and concentration of the injected drug. One of the major limitations of single injection technique is the relatively short duration of post-operative analgesia. So, addition of different adjunct drugs to the local anesthetic solution for prolonged analgesia postoperatively [(5)]. Caudal analgesia could reduce the amount of inhaled and intravenous anesthetic administrative, attenuate the stress response to surgery, facilitate rapid and smooth recovery and provide good immediate postoperative analgesia. In order to decrease intra- and post-operative analgesic requirements after single shout caudal blockade, various additives, such as opioids and non-opioids drugs were used [(6)].

Thus, addition of various drugs to local anesthetics has been used to prolong the pain-free period [(7)].

This work aims to compare the post-operative analgesic and any side effects of dexmedetomidine and fentanyl in adding one of them to bupivacaine in pediatric patients undergoing lower abdominal and lower limb surgeries.

PATIENT AND METHODS

This interventional randomized-controlled study was conducted in Department of Anesthesia and Intensive Care, Sohag university hospital. Sixty patients aged from 2 to 6 years who were going to do a lower abdominal surgery were included in the study.

Ethical approval:

An approval of the study was obtained from Sohag University Academic and Ethical Committee. Informed written consents were obtained from parents of all children participants before recruitment in the study after explaining the

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objectives of the work. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Exclusion criteria:

A history of developmental delay or mental retardation, a known or suspected coagulopathy, a known allergy to any of the study drugs, any signs of infection at the site of caudal block, and hemodynamic unstable patient.

Anesthesia was induced by face mask with sevoflurane and oxygen. In older children i.v. cannula was inserted and propofol 2 mg/Kg was used in induction. The trachea was intubated with the use of rocuronium 0.5 mg/Kg and the lungs were ventilated by controlled ventilation. Anesthesia was maintained (through Datex Ohmeda S/5 Aespire anaesthesia machine) with isoflurane (1.0-2.0%) using standard monitoring. Caudal anesthesia was performed with a 22-gauge needle under complete aseptic conditions, with the child in a left lateral position and immediately turned supine after injection of the drug, and then a glucose/saline solution was infused intravenously. Children were allocated randomly into one of two groups for caudal block and the mixture was administered on a weight-related basis into the caudal space in a dose of 1ml/kg.

Group D (n 30): received dexmedetomidine 1μg/ kg added to 0.25% of bupivacaine.

Group F (n 30): received fentanyl 1μg/kg added to 0.25% of bupivacaine.

Standard monitoring was used (Nihon Koden monitor) during anesthesia and surgery. Heart rate and blood pressure was recorded before induction and every 5 min until the end of surgery.

During surgery, adequate analgesia was defined by hemodynamic stability, as indicated by the absence of an increase in heart rate (HR) or systolic arterial pressure (SAP) of more than 20% compared to baseline values obtained just before the surgical incision, with isoflurane concentration maintained at approximately 1.0-2.0% MAC.

Bradycardia, was defined as a 20% decrease in HR compared to pre-operative values. It was treated with atropine 0.01 mg/kg i.v.

Hypotension, was defined as a 20% decrease in SAP compared to pre-operative values. It was treated with the use ephedrine 1-2 mg i.v.

If, more than 60 min after skin incision and HR or SAP increased by more than 20%, analgesia will be considered inadequate and the child should receive rescue opioid during operation (Fentanyl 1μg/ kg).

Anesthesia was discontinued when the wound dressing had been applied and the endotracheal tube was extubated.

Statistical analysis

Statistical package for social sciences (IBM-SPSS, version 20 IBM- Chicago, USA) was used for statistical data analysis. Data were expressed as mean, standard deviation (SD), number and percentage. Mean and standard deviation were used as descriptive value for quantitative data. Chi square test was used to compare the qualitative data between the two groups, and student t test was used to compare the means between the two groups. P value ≤ 0.05 was considered significant.

RESULTS

Table (1): Demographic data of the two groups

	Group	Mean	Std. Deviation	Std. Error Mean	t test	p value
Age (years)	D	3.433	1.1043	.2016	0.408	0.685 (NS)
	F	3.567	1.4065	.2568		
Weight (Kg)	D	13.80	3.221	.588	0.076	0.940 (NS)
	F	13.87	3.550	.648		
		Male	**Female**		**Chi square**	**p value**
Gender	D	24	6		0	1.000 (NS)
	F	24	6			

Group D: children received mixture of Dexmetedomedine (1μg/kg) and bupivacaine 0.25% (1mg/kg). Group F: children received mixture of fentanyl (1μg/kg) and bupivacaine 0.25% (1mg/kg).

Table (1) showed that there was no statistical significant difference between both groups.

Table (2): Various types of surgeries of the lower abdomen were studied in this thesis as follow

Type of surgery	Group		Total
	D	F	
Inguinal hernia	9	11	20
Paraumbilical hernia	0	2	2
Hypospadius	4	6	10
Epispaduis	0	1	1
Stone bladder	3	1	4
Undescended testes	5	3	8
Anal surgery	2	1	3
Splenectomy	1	1	2
Hydrocele	5	3	8
Urethroscopy	1	0	1
Fracture femur	0	1	1
Total	30	30	60

Table (2) showed the number of different types of operations in each group.

Table (3): The relation of intraoperative SBP (mmHg) in both groups

Time	Group	Mean	Std. Deviation	T test	P value
Pre	D	98.67	7.716	1.316	0.193
	F	101.60	9.460		
5 min	D	107.37	13.863	1.297	0.200
	F	112.63	17.403		
10 min	D	105.833	15.6846	0.135	0.893
	F	106.400	16.8167		
15 min	D	101.43	16.602	0.770	0.445
	F	104.43	13.428		
20 min	D	101.37	13.286	0.539	0.592
	F	103.37	15.390		
25 min	D	100.00	11.541	0.396	0.694
	F	101.39	14.602		
30 min	D	99.41	13.175	0.847	0.401
	F	102.78	13.511		
35 min	D	97.00	14.903	0.704	0.486
	F	100.35	14.805		
40 min	D	100.167	16.1630	0.066	0.948
	F	100.600	17.3855		
45 min	D	101.75	18.180	0.821	0.422
	F	96.08	13.463		
50 min	D	91.286	17.5852	0.065	0.949
	F	90.846	12.6613		
55 min	D	94.67	39.425	0.286	0.781
	F	98.88	12.766		
60 min	D	54.000		2.775	**0.032**
	F	96.286	14.2562		
65 min	D	51.000		2.911	**0.033**
	F	98.833	15.2107		
70 min	D	60.00		2.407	0.095
	F	103.75	16.256		
75 min	D	60.00		2.041	0.134
	F	102.25	18.518		
80 min	D	60.000		1.251	0.300
	F	96.500	26.0960		
85 min	D	72.00		1.257	0.428
	F	109.00	24.042		
90 min	D	67.00		1.407	0.393
	F	106.00	22.627		

As regards the operative and post-operative data, table (3) showed that there was no significant difference between both groups except after 60 and 65 minutes (mean 54.000 and 51.000 respectively) after caudal block there was a significant difference where the SBP was decreased in group D more than in group F.

Table (4): Postoperative SBP (mmHg) in both groups

Time	Group	Mean	Std. Deviation	T test	P value
0.5 H	D	95.33	6.814	1.544	0.128
	F	92.33	8.172		
1 H	D	95.33	7.761	2.499	**0.015**
	F	91.00	5.477		
1.5 H	D	96.00	5.632	4.284	**<0.001**
	F	89.33	6.397		
2 H	D	94.33	6.261	2.421	**0.019**
	F	89.67	8.503		
4 H	D	94.67	7.303	2.249	**0.028**
	F	90.00	8.710		
6 H	D	93.33	6.065	0.849	0.399
	F	92.00	6.103		
8 H	D	95.00	5.085	0.648	0.519
	F	94.00	6.747		
10 H	D	93.33	7.581	0.986	0.328
	F	91.67	5.307		
12 H	D	95.17	5.745		
	F	.	.		

Table (4) showed a significant difference between the two groups in SBP postoperatively.

Table (5): The relation of face, legs, activity, cry, consolability (FLACC) pain score between both groups

Time	Group	Mean	Std. Deviation	T test	P value
0.5 H	D	1.73	2.664	2.393	**0.020**
	F	3.03	1.326		
1 H	D	1.23	1.870	2.522	**0.014**
	F	2.30	1.368		
1.5 H	D	1.03	1.810	0.085	0.933
	F	1.00	1.174		
2 H	D	1.43	1.478	3.060	**0.003**
	F	.47	.900		
4 H	D	1.50	1.570	1.891	0.064
	F	2.57	2.661		
6 H	D	1.53	1.592	5.710	**<0.001**
	F	4.27	2.083		
8 H	D	2.20	1.972	5.110	**<0.001**
	F	4.43	1.357		
10 H	D	3.40	2.621	1.922	0.060
	F	4.37	.850		
12 H	D	3.40	2.513	0.066	0.947
	F	3.43	1.135		

Table (5) showed a significant difference between both groups at 6 and 8 hours postoperatively where the mean FLACC pain score of the fentanyl at 6 hours postoperatively was higher (4.24 $\pm$ 2.083) than that of the dexmetedomedine (1.53 $\pm$ 1.592) and at 10 hours there was no significant difference between two groups.

Table (6): Relation of the Richmond Agitation Sedation Scale between both groups

Time	Group D				Group F				Chi square	P value
	0	-1	+1	+2	0	-1	+1	+2		
0.5 H	2	23	5	0	5	11	14	0	9.784	**0.008**
1 H	4	23	3	0	10	12	8	0	8.301	**0.016**
1.5 H	12	17	1	0	18	11	1	0	2.486	0.289
2 H	23	7	0	0	18	12	0	0	1.926	0.165
4 H	20	9	0	1	19	8	3	0	4.084	0.252
6 H	18	9	3	0	10	8	12	0	7.745	**0.021**
8 H	17	7	6	0	15	4	11	0	2.414	0.299
10 H	18	9	3	0	23	5	2	0	1.953	0.377
12 H	16	10	4	0	13	8	9	0	2.456	0.293

Table (6) showed that there was a significant difference where the sedation (-1) is more in group D at ½ hour and 1 hour than that of group F and agitation (+1) is more in group F at 6 hours .

Table (7): The incidence of side effects between two groups

	Group		Total	Chi square	P value
	D	F			
Failed	2	0	2	2.083	0.149 (NS)
	100.0%	0.0%	100.0%		
Hypotension	1	4	5	2	0.157 (NS)
	20.0%	80.0%	100.0%		
Nausea & Vomiting	2	2	4	0	1 (NS)
	50.0%	50.0%	100.0%		
Vomiting	0	2	2	2.083	0.149 (NS)
	0.0%	100.0%	100.0%		
Total	5	8	13	0.936	0.333 (NS)

Table (7) showed that there was 2 cases failed in the study and there was no significant difference between the two groups in incidence of side effects.

Table (8): Numbers of children needed analgesia at 6 hours

	D	F	Chi square	P value
Needed	3	14	9.921	**0.002 (S)**
Not needed	27	16		

Table (8) showed that there was a significant difference between the two groups in analgesic requirements at 6 hours being more in F group.

DISCUSSION

The two groups were homogenous with reference to age, sex and body weight. Mean age of patients was 3.433 ±1.1043 and 3.567±1.4065 years old in group D and group F respectively and mean weight of patients was13.80 ± 3.221 and 13.87 ± 3.550 kg in group D and group F respectively.

Heart rate and systolic blood pressure were recorded at various intervals in peri-operative period. The dexmetedomidine group showed more stable haemodynamics than that of fentanyl especially at post-operative period. Intra-operatively, there was no significant difference between them except after 60 and 65 minutes there was a significant difference where hypotension occurred in dexmetedomidine due to type of operation (bleeding) and duration of operation were not similar in both groups. These results come in agreement with the study done by **Mahendru *et al.*** [8] who compared the intrathecal administration of fentanyl, clonidine and dexmedetomidine in the lower limb surgeries and concluded that the mean values of mean arterial pressure (MAP) and heart rate (H.R.) were comparable between the studied groups throughout the intraoperative and postoperative periods**. Dutt *et al.*** [9] compared the addition of fentanyl or dexmedetomidine to caudal ropivacaine in pediatrics who underwent lower abdominal and lower limb surgeries and concluded that hemodynamics were comparable between the two studied groups. **Nasr and Abdelhamid** [10] compared the efficacy of the caudal dexmedetomidine or caudal fentanyl on the stress response and postoperative analgesia and concluded that the HR & MAP were significantly decreased in the dexmedetomidine group.

As regards postoperative pain score and duration of analgesia, there was a significant difference where postoperative FLACC pain score was lower in group D (1.23 ± 1.870) than in group F (2.30 ±1.368) in first hour (P value **0.014)**, which indicate more potent analgesia in group D. At 6 and 8 hours mean FLACC pain score was > 4 in group F (4.27 ± 2.083 and 4.43 ± 1.357 respectively) where 12 children at 6 hours took paracetamol suppository as a supplemental analgesic, so mean duration of analgesia in the group F is up to 6 hours. At 10 and 12 hours there was no significant difference between both groups and mean FLACC pain score in group D was 3.40 ± 2.621 and 3.40 ± 2.513 respectively and 11 children at 10 hours in this group suffered from pain and took paracetamol suppository so mean duration of analgesia was 10-12 hours. These results come in agreement with the study done by **Xiang *et al.*** [11] who studied the effect of addition of dexmedetomidine to ropivacaine in caudal block in children who underwent inguinal hernia repair and concluded that the addition of dexmedetomidine to caudal bupivacaine could reduce the response to hernial sac traction, prolong the duration of postoperative analgesia and decrease postoperative analgesic requirements. In two studies, which were done by **Dutt *et al.*** [9] and **Nasr and Abdelhamid** [10] who compared caudal fentanyl or dexmedetomidine on lower abdominal and limb surgeries and cardiac surgery in pediatrics respectively and concluded that in dexmedetomidine group the pain score was decreased and the duration of postoperative analgesia was prolonged. In a study done by **El-Feky and Abdel Aziz**[12], they concluded that both caudal dexmedetomidine and caudal dexamethasone added to local anesthetics were good alternatives in prolongation of postoperative analgesia with less pain score compared to caudal local anesthetic alone or added to caudal fentanyl.

As regards sedation score, dexmetedomidine showed more sedation than that of fentanyl where there was a significant difference between both groups at ½ hour and 1 hour (P value 0.008 and 0.016 respectively) and number of children sedated in group D (23) was more than that of group F (8) at 1 hour. These results come in agreement with the study done by **Anand *et al.*** [13] who evaluated the effects of dexmedetomidine added to caudal ropivacaine in pediatric lower abdominal surgeries and found that dexmedetomidine group achieved significant postoperative pain relief with better quality of sleep and prolonged duration of arousal sedation. **Saadawy *et al.*** [14] studied the addition of dexmedetomidine to bupivacaine in caudal block in children and concluded that dexmedetomidine group had better quality of sleep and a prolonged duration of sedation. However, **Dutt *et al.*** [9] compared caudal fentanyl versus dexmedetomidine and concluded that sedation score was more pronounced in dexmedetomidine group. But this difference was due to high dose of dexmedetomidine (2 µg/kg).

As regards the incidence of side effects, there were two failed cases where the caudal procedure was difficult (subcutaneous injection). They were managed by fentanyl intravenous and these cases were excluded from the study. Incidence of other complications as hypotension, nausea and vomiting was similar in both groups (P value 0.157, 1 and 0.149 respectively). This result comes in agreement with **Dutt *et al.*** [9] who compared side effects of dexmetedomidine and fentanyl caudally and found insignificant results but this result show disagreement with **Bajwa *et al.*** [15] who evaluated the addition of either fentanyl or dexmedetomidine to epidural analgesia in lower limb surgeries and revealed that the incidence of postoperative nausea and vomiting was significantly high in the fentanyl group and also disagree with **El-Feky and Abd El Aziz**[12] who concluded that both caudal dexmedetomidine and caudal dexamethasone added to local anesthetics showed less side effects compared to caudal fentanyl.

CONCLUSION

Adding dexmetedomidine to bupivacaine in caudal block was longer in duration of postoperative analgesia and showed more sedation time than that of fentanyl with more stability in haemodynamics.

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