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Different Doses of Dexmetomedine as Adjuvant to Bupivacaine in Ultrasound Guided Transversus Abdominus Plane Block in Children Undergoing Lower Abdominal Surgery

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Abstract

Background: Post-operative pain management in pediatric patients is essential, development of safe and effective techniques is very important. The Transversus Abdominis Plane block (TAP block) has been tried successfully in adults for post-operative pain, its role in children remains unclear. Dexmedetomidine is a central α-2 agonist, causes sedation with minimal depression of respiration, making it safe for sedation during procedures. It is widely used for many procedures especially premedication, awake intubation, and sedation of patients in intensive care units and pediatric procedural sedation.

Methods: This is a prospective, randomized controlled double blinded trial. 90 patients (aged 2 years-7 years) were included in this study divided into 3 groups. All children received general anesthesia and ultrasound guided unilateral transversus abdominis plane block.

Group I (control group): Received plain bupivacaine 1 ml/kg

Group II: Received plain bupivacaine 1 ml /kg plus dexmetomedine 0.5 µg/kg

Group III: Received plain bupivacaine 1 ml /kg plus dexmetomedine 1 µg/kg

Results: TFAR was considerably longer in group III compared to group II and I, (p value<0.001) Postoperative FLACC values were elevated in group I than group II and III and became lower in group III than II at 6 hours, 8 hours and 12 hours postoperatively (p value<0.05). Cumulative number of analgesics doses in the postoperative 12 hours was lower in group III There were no considerable differences in occurrence of PONV and no complications were reported.

Conclusion: TAP block using bupivacaine, with the addition of dexmetomedine 0.5 mic/kg or 1 mic/kg provided analgesia in pediatric patients. No complications or undesirable events related to the block were reported.

Keywords: TAP block • Dexmetomedine • Operative pain

Abbreviations: TAP block: Transversus Abdominis Plane • ASA: American Society of Anesthesiology • ECG: Electro Cardio Gram • BIS: Bi Spectral Index • IOM: Internal Oblique Muscle • TFAR: The First Analgesia Request

Introduction

Development of safe and effective approaches for post-operative pain management in pediatric patients is crucial [1]. Historically, pain management in children has been poor, but in the last decades many advances have been made [2]. Although Transversus Abdominis Plane block (TAP block) has been successfully used to treat post-operative pain in adults, its relevance in children is unknown [3]. Rafi was the first to define TAP Block in 2001 [4]. It's a compartmental block, which means it relieves painin the parietal peritoneum, skin and muscles of anterior abdominal wall [5].

Dexmedetomidine is a central α-2 agonist camparable to Clonidine, but 8 times more selective for the central α-2 receptor, causing sleepiness with less respiratory depression, making it safe for sedation. It is commonly used for premedication, awake intubation, and sedation of patients in intensive care units as well as pediatric sedation [6]. Pediatric anesthesiologistsare still interested in possibility of apoptosis in young children. Only dexmedetomidine and possibly xenon has been judged "safe" among the anesthestics implicated in triggering apoptosis in baby rodents [7]. If human research on apoptosis confirms a risk of neurocognitive impairment in young children following anesthesia, dexmedetomidine could be crucial in providing safe anesthesia to this age group [8]. The aim of this study was to compare the duration of analgesia and adverse effects of three different doses of dexmetomedine added to bupivacaine in ultrasound guided TAP block in pediatric patients.

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Materials and Methods

After the approval of the ethical committee of the department of anesthesia, Menoufia University, and after obtaining a written parental consent, this study was conducted on ninety children of both sexes in Menoufia University hospitals.

Study design

This is a prospective, randomized controlled double blinded trial. Patients were randomized using a computerized computer program.

Inclusion criteria

- Aged 2-7 years.
- Physical status I of the American Society of Anesthesiology (ASA)
- Scheduled for uncomplicated elective unilateral lower abdominal surgeries (unilateral inguinal hernia, unilateral hydrocele,

unilateral undescended testis

Exclusion criteria

- Patients with pre-existing coagulation disorder or under anticoagulation therapy
- Infection around needle insertion
- Patients suffering from neuromuscular disease or neurological disorder or history of seizures
- Congenital anomalies of lower spine or meninges.

Methods

Preoperative preparation: All patients were fasting according to the American Society of Anesthesiology (ASA) fasting guidelines, reassured and premedicated by oral midazolam 0.5 mg/kg and atropine 0.01 mg/kg [9]. Patients were divided randomly into three equal groups 30 patients each. Standard monitors including Electro Cardio Gram (ECG), pulse oximetry, and non-invasive blood pressure (Life Scope NIHON KOHDEN) were applied followed by induction of general anesthesia with a high initial concentration of sevoflurane in 100% oxygen by face mask. Starting with a concentration more than 4 till loss of eye lash reflex, establishment of regular breathing, and return of conjugate gaze. Then an intravenous cannula 22 gauge was placed. Fentanyl 1 µg/kg was given and appropriate size Laryngeal Mask (LMA) was placed. Capnogram and Bi Spectral Index (BIS) were applied.

Anesthesia was maintained with sevoflurane in oxygen 100% till the end of surgery aiming at maintaining BIS values near 50 through increasing or decreasing inspired sevoflurane concentration. The iliac crest and costal margin are palpated while the patient is in supine position, and the space between them in the mid-axillary line identified as the initial transducer location.

The skin is sterilized with 10% povidone iodine solution while the patient is supine, and the transducer is put on the skin. It's important to recognize three muscle layers. Identification is aided by sliding the transducer slightly cephalad or caudad. The needle is inserted to the medial aspect of the transducer, and in-plane in a medial to lateral orientation once the transversus abdominis plane has been determined. The needle is guided through the skin, subcutaneous tissue, External Oblique Muscle (EOM), and Internal Oblique Muscle (IOM) under constant visualization.

As the needle tip enters the plane between the two muscles, a "pop" may be felt. After gentle aspiration, 1 ml to 2 ml of normal saline was injected to confirm the needle tip;s position then local anesthetic was injected. Ideal observation of local spread will show a hypoechoic "lemon"-shaped spread of local anesthetic between fascial planes, as opposed to the more circular-shaped appearance of an intramuscular injection. When the local injection looks to be intramuscular, the needle is carefully advanced or withdrawn 1 mm to 2 mm and another bolus is administered. This gesture is repeated until the correct plane is reached. Bupivacaine 0.125% is injected in a volume of 1 ml/kg.

Group I (control group): Received plain bupivacaine 1 ml/kg

Group II: Received plain bupivacaine 1 ml/kg plus dexmetomedine 0.5 µg/kg

GROUP III: Received plain bupivacaine 1 ml/kg plus dexmetomedine 1 µg/kg

Measurements

Sevoflurane concentrations required to maintain adequate depth of anesthesia as well as required incremental doses of intraoperative fentanyl weremeasured during surgery. The use of BiSpectral Index (BIS=40-50) and hemodynamic endpoints guided the the titration of Sevoflurane (MAP and HR within 20% of the baseline). If BIS exceeded 50, Sevoflurane was increased to 4%. If the desired hemodynamic value (20% of preanesthesia values) were not achieved, a fentanyl bolus (1 µg/kg) was given, followed by 0.5 µg/kg boluses every 10 minutes as needed.

Hemodynamics were measured before the block of 5 min, 10 min, 15 min, 30 min, and 60 min thereafter. The entire fentanyl administered (including the induction dose) and number of cases who needed additional boluses of fentanyl were recorded. Recovery Time: The time from discontinuing anesthesia to spontaneous removal of LMA with the patient awake (spontaneous eye opening) were recorded. LMA was detached and patient transported to post anesthesia care unit at the end of the surgical procedure and sevoflurane cessation. Postoperatively; MAP, HR and The Faces, Legs, Activity, Crying and Consolability (FLACC) behavioral pain assessment scale were recorded on admission to PACU (Post-Anesthetic Care Unit) and after 0.5 hr, 1 hr, 2 hrs, 4 hrs, 6 hrs, 8 hrs, and 12 hrs post-operatively [10].

The time elapsed till The First Analgesia Request (TFAR) was recorded. It was the time from the achievement of TAP block to first given rescue diclofenac when FLACC was 4 or more. Thereafter, analgesia was maintained using I.V. diclofenac (Voltaren) 1 mg/kg in 20 ml 0.9% sodium chloride. If the FLACC score is still ≥ 4 after 30 minutes, paracetamol (Perfalgan) 20 mg/kg IV was given. The total postoperative (12 hrs) rescue analgesics expenditure was recorded. After 2 hrs and 12 hrs, the sites of injection were examined to detect complications as hematoma or infection.

Occurrence of Post-Operative Nausea and Vomiting (PONV) and pruritus was recorded. The primary outcome was postoperative analgesia (evaluated by TFAR, FLACC and cumulative doses of rescue pain killers (diclofenac and paracetamol) in the postoperative 12 hours). The secondary outcomes included hemodynamics, analgesic and anesthetic requirements used intraoperatively, occurrence of post-operative side effect and complications and surgeon satisfaction.

Results

Patients' demographic and operative data were equivalent amongst the groups (Table 1). Use of intraoperative fentanyl was considerably lower in groups II and group III regarding the amount (articulated as number of

Table 1. Patients' demographic and operative data.

Parameters		Group I (N=30)	Group II (N=30)	Group III (N=30)	p value
Age (year)		4.03 ± 1.56	4.17 ± 1.72	3.97 ± 1.69	0.89
Weight (kg)		16.40 ± 3.28	15.87 ± 3.01	16.23 ± 3.17	0.8
Sex	Male	23 (76.7)	25 (83.3)	24 (80.0)	0.82
	Female	7 (23.3)	5 (16.7)	6 (20.0)	
Surgical procedures	Hernia canal of nuck	7 (23.3)	5 (16.7)	6 (20.0)	0.9
	Hydrocele	10 (33.3)	8(26.7)	11 (36.7)	
	Undescended testis	7 (23.3)	10(33.3)	9 (30.0)	
	Inguinal hernia	6 (20.0)	7 (23.3)	4 (13.3)	
Duration of surgery (minutes)		86.31 ± 8.81	86.11 ± 11.18	83.15 ± 8.35	0.665

Table 2. Comparison between the studied groups as regards operative events.

Parameters	Group 1 N=30 $\bar{x}\pm SD$ (Range)	Group 2 N=30 $\bar{x}\pm SD$ (Range)	Group 3 N=30 $\bar{x}\pm SD$ (Range)	T-Test	p Value
Total Sevolourane consumption (ml)	104.83 ± 22.91 (75-150)	57.33 ± 12.58 (35-80)	52.17 ± 9.07 (35-70)	9.95 11.71 1.83	<0.001[a] <0.001[b] 0.07[c]
Total fentanyl consumption (µg/kg)	2.77 ± 0.43 (2-3)	1.0 ± 0.0 (1-1)	1.0±0.0 (1-1)	86.4	0.14
				U test	
Recovery time (min)	15.13 ± 5.18 (6-25)	6.40 ± 1.33 (5-10)	4.90 ± 0.88 (4-7)	6.35 6.68 4.35	<0.001[a] <0.001[b] <0.001[c]
TFAR (hours)	0.92 ± 0.49	3.63 ± 0.89	11.47 ± 1.38	-	<0.001*
Cumulative number of analgesics doses	0	0	26 (86.7)		
0	0	1 (3.3)	4 (13.3)		
1	0	19 (63.3)	0		
2	14 (46.7)	7 (23.3)	0	<0.01*	-
3					
4	16 (53.3)	3 (10.0)	0		
No. of fentanyl increments	No	%	No %	No %	χ_2	
None	0	23.3	30 100	30 100		
1 dose	7	76.7	0 0	0 0	90	<0.001*
2 doses	23	-	0 0	0 0		
Surgeon satisfaction	25	83.3	30 100	30 100	10.59	0.005
yes						
no	5	16.7	0 0	0 0		

a=comparing group 1 and group 2, b=comparing group 1 and group 3 and c=comparing group 2 and group 3, *=Statistical significance at p-value ≤ 0.05

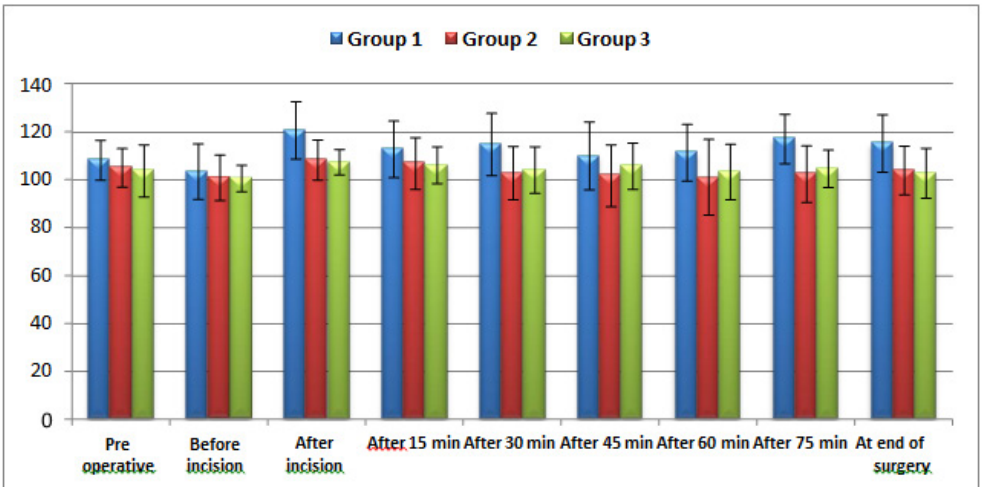

Figure 1. Intraoperative heart rate changes.

increments) and number of patients who needed additional increments of fentanyl (Table 2). Total sevoflurane consumption was considerably more in group I (104.83 ± 22.91) than group II (57.33 ± 12.58) and group III (52.17 ± 9.07) (Figure 1). TFAR was considerably longer in group III compared to group II and group I, (P value<0.001). Postoperative FLACC values were elevated in group I than group II and group III and became lower in group III than group II at 6 hours, 8 hours and 12 hours postoperatively (P value<0.05) (Figure 2).

Data of age, weight, and time of surgery presented as mean ± SD and tested by ANOVA. Data of sex and types of surgical procedures presented as number (percentage) and tested by Chi-square test. p value>0.05 denotes statistical insignificance.

Data are presented as mean (χ^2) ± SD, range or number (No) and percentage (%) as appropriate. χ^2= Chi squared test. U=Mann Whitney U test *p<0.05 denotes statistical significance. a=comparing group 1 and group 2, b=comparing group 1 and group 3 and c=comparing group 2 and group 3, *=Statistical significance at p-value ≤ 0.05. Number of fentanyl increments and cumulative number of analgesic doses expressed as number (percent) and tested by Chi-square test. Time for First Analgesic Request (TFAR) expressed as mean ± SD and tested by t-test. P value<0.05 denotes statistical significance between groups.

Cumulative number of analgesics doses in the postoperative 12 hours was lower in group III 26 patients (86.7%) needed no analgesics throughout the initial 12 hours following surgery. All through the first 12 hours postoperatively, 4 patients (13.3 %) received 1 analgesic dose in group III. In group II 1 patient (3.3%) received 1 dose, 19 patients (63.3%) received 2 doses, 7 patients (23.3%) received 3 doses and 3 patients (10%) received 4 analgesics doses. Number of cummulative doses of analgesics was elevated in group I 14 patients (46.7%) received 3 doses and 16 patients (53.3%) received 4 doses of analgesics, (p value <0.001).

There have been statistically considerable ascents in intraoperative Heart Rate (HR) and MAP within group I after skin incision, 30 minutes after initiation of anesthesia and at end of surgical process. No hemodynamic reaction to skin incision was reported in group II or III. No hemodynamic fluctuation was recorded postoperatively except for an ascent in heart rate and MAP within group II at 6, 8 and 12 hours (p<0.05) (Figure 3). There were

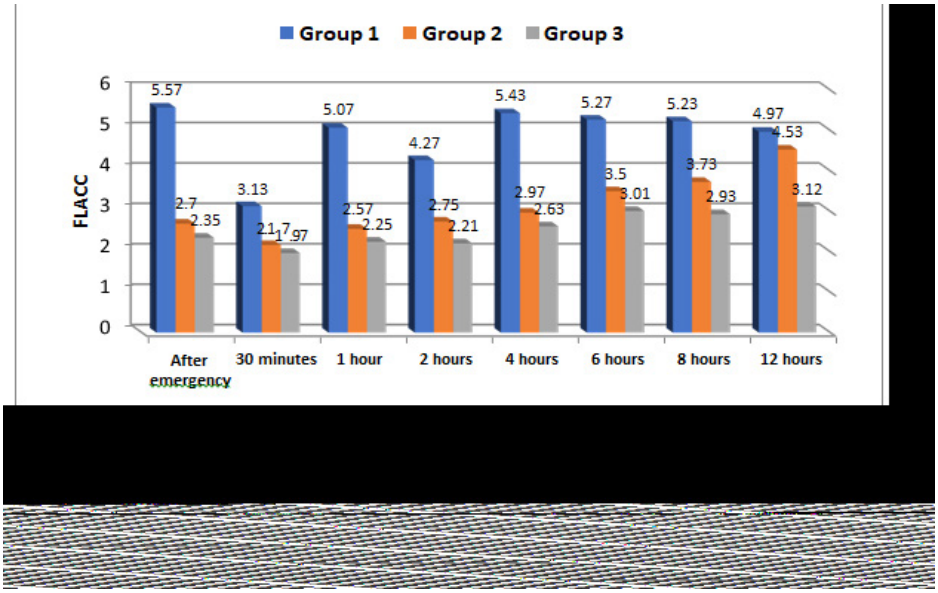

Figure 2. Intraoperative Mean Arterial Blood Pressure (MAP) changes.

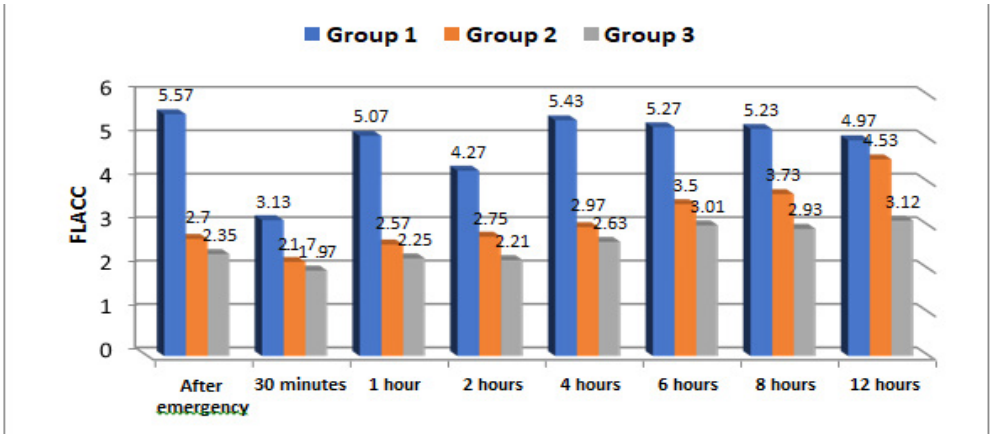

Figure 3. Postoperative FLACC scale.

Table 3. Comparison between the studied groups as regards post-operative analgesia.

Parameters	Group 1	Group 2	Group 3	T test	p value
Time to first analgesic request (hrs)	0.92 ± 0.49 (0.5-2)	3.63 ± 0.89 (2-5)	11.47 ± 1.38 (8-12)	916.3	<0.001
				U	p value
Duration of analgesia (min)	145 ± 20	322.33 ± 48.63 (195-400)	775.33 ± 77.84 (580-820)	6.66	<0.001
Number of patients requiring diclofenac	30 (100%)	30 (100%)	4 (13.3%)	73.1	<0.001
Number of patients requiring paracetamol	30 (100%)	10 (33.3%)	0 (0.0%)	90	<0.001
Cumulative number of doses of analgesics	0 (0.0)	0 (0.0)	26 (86.7)	132	<0.001
0	0 (0.0)	1 (3.3)	4 (13.3)		
1	0 (0.0)	19 (63.3)	0 (0.0)		
2	14 (46.7)	7 (23.3)	0 (0.0)		
3	16 (53.3)	3 (10.0)	0 (0.0)		
4					

no considerable differences in occurrence of PONV and no complications were reported (Tables 3 and 4).

Data are presented as range, meanX+SD, Patients needed additional doses of diclofenac and paracetamol expressed as number (percent) and tested by Chi-square test. Diclofenac consumption tested by Kruskal- Wallis test. Duration of analgesia and paracetamol consumption tested by Mann Whitney U test. Time to first analgesic request tested by t-test.

Discussion

We discovered that addition of all 2 doses of dexmedetomidine lead to a considerable reduction in intraoperative fentanyl necessities and sevoflurane TFAR was considerably longer in group III. FLACC score was considerably lower in group III. It was low within group II till 4 hours postoperative. At 6 hours postoperative and thereafter, FLACC became higher within group II. Number of cumulative doses of rescue analgesics was considerably lower within group III and highest in group I.

In agreement with our study, several randomized controlled studies established that single-shot TAP block increases the time till the first analgesic demand for up to 48 hrs and decreases morphine utilization.

Table 4. Postoperative Nausea and Vomiting (PONV). PONV among the study groups expressed as number (percent) and tested by Chi-square.

Parameters	Group 1 N=30	Group 2 N=30	Group 3 N=30	χ^2	p value
Nausea and vomiting	3 (10.0)	2 (93.3)	1 (3.3)	1.07	0.59
Yes					
No	27(90.0)	28 (6.7)	29 (26.7)		

This comes in agreement with El Sadek and his workfellows who compared ultrasonography guided TAP blockade with ultrasonography guided caudal blockade in children and reported that TAP provided lesser pain scores and considerably less need for analgesics from 6 hrs to 12 hrs postoperatively [11]. The analgesic effectiveness in TAP group could be explained as TAP block extends up to 24 hrs. McDonnell and his workfellows contributed this to the fairly scantily vascularized TAP resulting in a slow rate of drug clearance [12].

This comes in cosistence with Mukhtar and Singh, Fredrickson and his workfellows, Carney and his workfellows, El-Dawlatly and his workfellows and Tanaka and his workfellows studies where TAP blockade reduced morphine requirements and lowered pain scores for up to 48 postoperative hours [13-17]. Patients receiving 1 mic/kg and 2 mic/kg caudal dexmedetomidine had longer postoperative analgesia and lower FLACC pain score in previous trials. During 24 postoperative hours, 77% of the children receiving 1 mic/kg caudal dexmedetomidine with bupivacaine did not require further analgesia, compared to just 10% children getting bupivacaine alone [18]. Previous studies haven't evaluated the efficacy of 0.5 mic/kg dexmedetomidine.

Our research not only verified the analgesic benefit of TAP block using bupivacaine, but also found that adding dexmetomedine 0.5 mic/kg or 1 mic/kg to bupivacaine gave even better analgesia. In comparison to the group receiving bupivacaine and saline, patients in dexmedetomidine and bupivacaine had lower postoperative pain scores at 6, 8, 12, postoperatively, a longer analgesic duration, and lower 12 hrs analgesic use, as well as lower incidence of postoperative nausea and/or vomiting, as well as early ambulation.

In this trial, adding dexmedetomidine to bupivacaine did not result in an increase in the incidence of side effects or a delay in recovery from general anesthesia. There was no nausea, vomiting, or pruritus in any of patients. No complications or undesirable events related to the block were reported throughout the study. Fredrickson, Hebbard and their workfellows established the value of direct ultrasonography imaging with good outcome in children in inguinal herniorrhaphies [19].

Conclusion

The addition of the 2 doses of dexmedetomidine to bupivacaine for TAP block significantly increased the duration of postoperative analgesia in children undergoing lower abdominal and perineal surgeries. Dexmedetomidine in these doses seems to be safe and without any side effects. Dexmedetomidine 0.05 mic/kg given as a single dose, is recommended for further research since it appears to be effective dose for postoperative analgesia and can be used in day case surgery.

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