Randomized Controlled Trial

Effect of Dexmedetomidine, Dexamethasone, and Ondansetron on Postoperative Nausea and Vomiting in Children Undergoing Dental Rehabilitation: A Randomized Controlled Trial

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Background: Postoperative nausea and vomiting (PONV) are common unpleasant adverse effects after surgery. The incidence of PONV in pediatric patients is often twice as high as in adults.

Objectives: This study aimed to evaluate the effects of dexmedetomidine, dexamethasone, and ondansetron for preventing PONV in children undergoing dental rehabilitation surgery.

Study Design: A prospective, randomized controlled clinical trial.

Setting: Sharurah Armed Forces Hospital, Ministry of Defense Medical Services, Saudi Arabia.

Methods: One hundred patients (6-12 years old) scheduled for dental rehabilitation were included. Patients were randomly allocated into 4 groups (25 each) to receive either 0.15 mg/kg dexamethasone (DEX), 0.05 mg/kg ondansetron (OND), 0.3 µg/kg dexmedetomidine (DEXMED), or normal saline (control[CONT]) in DEX, OND, DEXMED or CONT groups, respectively, via infusion after induction of anesthesia. The primary outcome was a PONV incident in the first 24 hours. Secondary outcomes were: granisetron doses during 24 hours postoperative, Paediatric Anaesthesia Emergence Delirium (PAED) scale, Pediatric Objective Pain Scale (POPS) for 4 hours postoperatively, and complications in the first 24 hours.

Results: The reduction of PONV and the overall number of patients who developed PONV was statistically significant in the DEXMED group compared to the CONT group ($P = 0.041$). However, the DEXMED group was higher compared to the DEX and OND groups but not statistically significant. Granisetron requirements and doses were statistically significantly lower in the DEXMED group than in the CONT group. PAED and POPS scores were much better in the DEXMED group than in the other groups with a statistically significant difference in most of the time measurements.

Limitation: Optimal dexmedetomidine dose for better effect on PONV without affecting hemodynamic stability requires more studies.

Conclusion: Dexmedetomidine is effective in reducing PONV in children undergoing dental rehabilitation with better sedative and analgesic scores as compared to the control group.

Key words: Dexmedetomidine, dexamethasone, dental rehabilitation, ondansetron, postoperative nausea and vomiting

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Nausea and vomiting are frequent and undesirable postoperative side effects after general anesthesia; they have a major postsurgical effect (1). Postoperative nausea and vomiting (PONV) have an incidence of 20% - 40% in general, and up to 80% in special risk groups like oral, maxillofacial, and dental surgeries in absence of prophylaxis. Furthermore, the incidence of PONV in pediatrics is double that in adults (2). Wound dehiscence, prolonged hospital admission, readmission, dehydration, and electrolyte imbalance are possible complications of prolonged PONV. Additionally, esophageal rupture, aspiration, and pneumothorax may result from severe vomiting (3).

Currently, dental caries has become a common health problem in children. General anesthesia is indicated for extensive dental treatment for those who exhibit anxiety and cognitive immaturity or are medically compromised (4). However, due to the longer durations of procedures, the swallowing of blood clots, and opioid administration for pain control, PONV incidences are expected to increase (5). PONV has multifactorial etiology, which may include a central mechanism through vestibular system activation followed by excitation of the central pattern generator in the medulla oblogonta (the vomiting center) caused by surgical pain and anxiety (6,7). Furthermore, a peripheral mechanism through direct gastric stimulation caused by surgery, blood, or toxins induces the discharge of serotonin and substance P from enterochromaffin cells, thereby activating the vagal and splanchnic nerve serotonin 5-hydroxytryptamine (5-HT3) receptors. Moreover, opioids and inhalation anesthetics induce PONV mediated by central excitement of the area posterna centrally which communicates with the central pattern generator via dopamine and serotonin receptors (8).

Dexamethasone has been applied as a part of a multimodal antiemetic strategy in all age groups. Its antiemetic action is through a central effect in the central pattern generator (the vomiting center) mediated by suppression of prostaglandin synthesis (9). Ondansetron is commonly used for the prevention of PONV owing to its antagonist effect on the 5-HT3 receptor. Despite its high cost, its prophylactic effect is high with minimal side effects (10). Dexmedetomidine has been frequently implemented in pediatrics either for sedation or together with general anesthesia with minimal respiratory compromise (11,12). Prior studies in pediatrics have documented the effects of dexmedetomidine regarding sedation and analgesia, together with reduced opioid consumption and improved recovery quality (13). Furthermore, little research has studied the impact of dexmedetomidine on reducing PONV in adults (14). Nevertheless, dexmedetomidine effects on PONV in pediatrics remain poorly investigated. This study aimed to investigate the outcome of a single dose of dexmedetomidine after induction of general anesthesia on PONV in children undergoing dental rehabilitation surgery and compare its effect with dexamethasone and ondansetron.

Methods

We conducted a randomized double-blind controlled clinical trial. It was carried out at Sharurah Armed Forces Hospital, Medical Services, Ministry of Defense, Saudi Arabia from November 2021 through April 2022, after approval from the hospital's ethical committee with decision number IRC 13407/10/21. It was registered at clinical trials.gov (NCT 05124067). We obtained written informed consent from parents or guardians.

The study enrolled 100 pediatric patients of both genders (6-12 years old), scheduled for dental rehabilitation procedures under general anesthesia and who had an American Society of Anesthesiologists (ASA) physical status or I or II. Study exclusions included those who had any contraindication to the studied drugs, a history of gastroesophageal reflux disease or conditions associated with delayed gastric emptying, intake of antiemetic medication or glucocorticoids medications in the previous 24 hours before surgery, a family history of previous PONV, prolonged cardiac QT interval, and parental refusal to participate in the study or sign consent.

Randomization and Allocation Concealment

Randomization was done by a computer-generated random sequence in opaque and numbered envelopes; the envelope that determined the group assignments was chosen by a blinded nurse. Patients and investigators were unaware of the medications and their doses. Patients were assigned randomly into 4 groups (25 each) with a 1:1:1:1 ratio to receive either 0.15 mg/kg intravenous (IV) dexamethasone (Sigma-Tec pharmaceuticals) (4 mg/mL, maximum 5 mg in group DEX (10); 0.05 mg/kg IV ondansetron (Dansetron, Hikma pharmaceuticals) (maximum 4 mg) in group OND (10); or dexmedetomidine HCL (Gland Pharma Limited) (vial = 2 mL) 100 µg/mL in a dose of 0.3 µg/kg by infusion (15) in group DEXMED, and normal saline in the same

volume in group CONT (control group). To ensure a double-blind study, all the studied medications were prepared by another anesthesiologist not involved in the study and were diluted to be given in similar volumes (20 mL), then infused slowly for 10 minutes after anesthesia induction.

Anesthetic Technique

A preanesthesia assessment was done the day before surgery per hospital policy and procedures. Complete fasting was ensured with a preoperative nothing by mouth protocol (6 hours for solids and up to 2 hours for clear fluids). Basic data were recorded before giving oral midazolam 0.5mg/kg in 5 mL clear juice. Glycopyrrolate (4 µg/kg) was injected intramuscularly 30 minutes before peripheral cannulation and transportation to the operating theater.

Upon arrival at the operating theater, basic monitoring of vital data (heart rate, electrocardiograph leads II and V, noninvasive blood pressure, temperature, oxygen saturation, and end-tidal CO_2) were started. Immediately after patient identification and pre-induction assessment, anesthesia was induced with sevoflurane inhalation plus fentanyl (1 µg/kg). Nasal intubation was facilitated with cisatracurium (0.15 mg/kg) using reinforced armored tubes. Anesthesia was maintained by sevoflurane 2%-3% and 2 mg increments of cisatracurium. Monitoring of heart rate, oxygen saturation, respiratory rate, mean arterial blood pressure, temperature, and end-tidal CO_2 were performed throughout the procedure and documented in the anesthesia record. lactated Ringers solution was infused initially at a rate of 10 mL/kg/h then reduced according to the 4-2-1 rule after one hour. Additionally, 10 mg/kg of acetaminophen was infused for analgesia maintenance.

In all patient groups, the dental procedure performed included tooth extraction, root canal treatment, and pulpotomy and was performed by the same dentist. The depth of anesthesia was monitored and maintained from 40 to 60 by bispectral index (BIS Monitor). After finishing the dental procedure, sevoflurane was discontinued and the muscle relaxant was reversed using 50 µg/kg of neostigmine and atropine (0.02 mg/kg) before extubation.Patients were then sent to the postanesthesia care unit (PACU).

All attacks of vomiting, retching, and nausea were recorded in the PACU and the ward during the first 24 hours of recovery by a registered nurse who was blinded to the study. All the parents and their children were oriented to be familiarized with the Pictorial Baxter Retching Faces (BARF) scale during the preanesthesia visit. The scale is a reliable and validated pictorial rating method formed of 6 faces giving a zero to 10 scoring range for nausea identification and evaluation in pediatric patients who are ≥ 6 years old. Granisetron (0.1 mg/kg) was given if the scale was above 4 or if vomiting occurred more than twice in 5 minutes and repeated if necessary but not in less than 12 hours (16).

Vomiting was identified as forceful expulsion of even a minimal amount of gastric contents through the mouth, while retching was defined as an effort to vomit without gastric content expulsion. The total dose of granisetron and the number of patients who required a rescue antiemetic were recorded.

Evaluation of emergence delirium was measured by the Pediatric Anesthesia Emergence Delirium (PAED) scale at 4 time points: at extubation, 5, 10, and 15 minutes after extubation and reported as T0, T1, T2 and T3 respectively (17). The PAED scale has a range of zero to 20 from 5 items: eye contact, environmental orientation, controllability, purposeful movement, and restlessness; each item has a score of zero to 4. Severe agitation was reported if a PAED score ≥ 10, which was then treated with intravenous midazolam (0.05 mg/kg).

Evaluation of postoperative pain was recorded using the Pediatric Objective Pain Scale (POPS) at postoperative 15 minutes, 30 minutes,one hour, 2 hours, and four hours. POPS has a score range of zero to 10 from 5 components: crying, posture, movement, agitation, and blood pressure; each item has a score from zero to 5 (18). Any adverse effects in the first postoperative 24 hours like hypotension, bradycardia, mouth edema, and high blood glucose were monitored and documented.

Study Outcomes

The episodes and the total patients who developed nausea, retching, and vomiting during the first 24 hours postoperatively were considered primary outcomes.

Furthermore, the total dose of rescue antiemetics that was given and the total number of children who requested granisetron, assessment of emergence delirium, postoperative pain measured by POPS, and any postsurgical complications were reported as secondary outcomes.

Statistical Analysis

Statistical analyses were performed using SPSS Version 24 (IBM Corporation).

Quantitative data are presented as mean ± standard deviation (SD). A one-way analysis of variance (ANOVA) was used if comparing more than 2 means. Multiple comparisons between different variables was done by a post hoc test. A χ^2 test was used to compare proportions between 2 qualitative parameters. The level for all analyses was set as $P < 0.05$.

Sample Size Calculation

Our primary objective was postoperative emetic episodes, originated from previous study outcomes (19). PONV incidence in group CONT was about 45%. Therefore at least 23 patients as a sample size were required for a significant reduction of 40% at an α error of 0.05 and a power of study of 90%. Assuming a dropout rate of 10%, 25 patients were enrolled per group.

Results

In total, 120 patients were enrolled. Ten patients did not meet our inclusion criteria and 10 patients declined to participate in our present study, so 100 patients were included and allocated into 4 groups randomly (25 each) as presented in the Consolidated Standards of Reporting Trials (CONSORT) flow chart of shared groups (Fig. 1).

Demographic data were comparable among the groups, including age (in years), gender, ASA physical status classification of I or II, body weight in kilograms, surgery and anesthesia duration (in minutes), with *P* values as shown in Table 1.

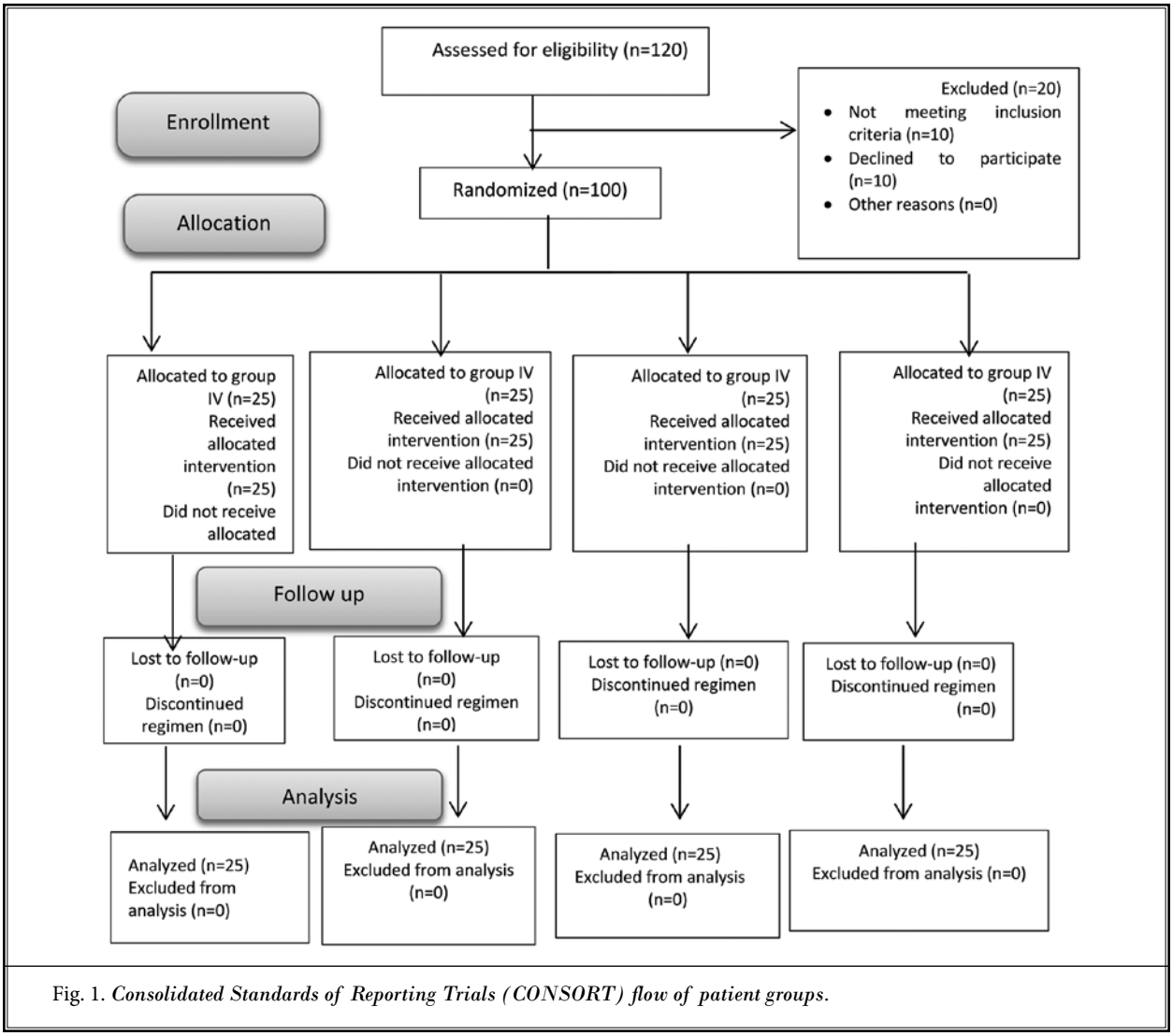

Fig. 1. *Consolidated Standards of Reporting Trials (CONSORT) flow of patient groups.*

The percentage of and overall PONV (nausea, vomiting, retching), were statistically significantly reduced in groups DEX, OND, and DEXMED when compared to group CONT. (P3 = 0.018, P5 = 0.007, P6 = 0.041) respectively. However, they were comparable among the first 3 groups (DEX, OND, DEXMED) (P1 = 0.713, P2 = 0.732, P4 = 0.733). The percentage of patients who developed PONV was 20%, 16%, 24% and 52% in DEX, OND, DEXMED and CONT groups respectively. Moreover, all episodes of nausea, retching and vomiting in all groups were reported in (Table 2) (Fig. 2).

Regarding the number of patients who required a rescue antiemetic, it was reduced in group OND (one patient) in comparison to other groups (2, 3, and 9 in DEX, DEXMED, and CONT groups respectively). Additionally, the number of patients who required antiemetics in groups DEX, OND and DEXMED were lower statistically compared to group CONT (P3 = 0.017, P5 = 0.005, P6 = 0.047) respectively. However, there was no significance among DEX, OND, and DEXMED groups (P1 = 0.552, P2 = 0.637, P4 = 0.297) respectively (Table 3) (Fig. 3).

The total granisetron doses (mg) was reduced more in group OND than in other groups. There was a statistical significance among groups DEX, OND, DEXMED, and group CONT (P3 = 0.001, P5 = 0.001, P6 = 0.014) respectively. Doses required in groups DEX, OND, DEXMED and group CONT were 5 mg, 3 mg, 9 mg, and 15 mg respectively.

Table 1. *Demographic and clinical data of studied groups.*

		DEX	OND	DEXMED	CONT	Test	*P* value
Age (years)	Range	6 – 12	7 – 12	6 – 11	7 – 12	F: 0.341	0.796
	Mean ± SD	8.52 ± 1.50	8.92 ± 1.35	8.68 ± 1.63	8.80 ± 1.35		
Gender	Boys (%)	15 (60%)	14 (56%)	13 (52%)	16 (64%)	χ2: 0.821	0.844
	Girls (%)	10 (40%)	11 (44%)	12 (48%)	9 (36%)		
ASA Physical Status	I (%)	10 (40%)	13 (52%)	15 (60%)	14 (56%)	χ2: 2.244	0.523
	II (%)	15 (60%)	12 (48%)	10 (40%)	11 (44%)		
Weight (kg)	Range	21.2 – 31.6	21.5 – 31.2	20.5 – 31.5	20 – 32	F: 0.454	0.715
	Mean ± SD	26.48 ± 2.58	25.63 ± 2.53	25.74 ± 2.79	25.75 ± 3.58		
Duration of surgery (minutes)	Range	65 – 180	60 – 160	70 – 155	62 – 180	F: 0.097	0.962
	Mean ± SD	101.60 ± 32.68	104.04 ± 30.96	103.56 ± 25.23	106.12 ± 29.98		
Duration of anesthesia (minutes)	Range	82 – 200	85 – 195	75 – 176	79 – 197	F: 0.116	0.950
	Mean ± SD	122.48 ± 32.95	126.00 ± 32.11	121.36 ± 26.42	124.48 ± 29.36		

Group DEX included patients who received dexamethasone; group OND included patients who received ondansetron; group DEXMED included patients who received dexmedetomidine and group CONT included patients who received saline. (N) = Number of patients in each group; (%) = percentage of either boys or girls. Data presented as mean±standard deviation (SD). *P*-value indicates the significance of the difference between groups. * Denotes statistically significant difference ($P < 0.05$).

Table 2. *Number and percentage of patients who developed nausea, retching, vomiting and overall PONV among the 4 groups.*

	DEX		OND		DEXMED		CONT		χ^2	*P* value
	N	%	N	%	N	%	N	%		
Nausea	3	12	2	8	4	16	5	20	1.658	0.646
Retching	4	16	3	12	3	12	6	24	1.786	0.618
Vomiting	1	4	1	4	2	8	5	20	5.249	0.154
All patients	5	20	4	16	6	24	13	52	9.916	0.019*
P1: 0.713, P2: 0.732, P 3: 0.018*, P 4: 0.733, P 5: 0.007*, P 6: 0.041*										

Data is presented as the number and percentage of patients. Group DEX included patients who received dexamethasone; group OND included patients who received ondansetron; group DEXMED included patients who received dexmedetomidine and group CONT included patients who received saline. (N) = Number of patients in each group; (%) = percentage. Data presented as mean ± standard deviation (SD). P value indicates the significance of the difference between groups: P1:DEX & OND. P2: DEX & DEXMED. P3: DEX & CONT. P4: OND & DEXMED. P5:OND & CONT. P6: DEXMED & CONT. * Denotes statistically significant difference ($P < 0.05$).

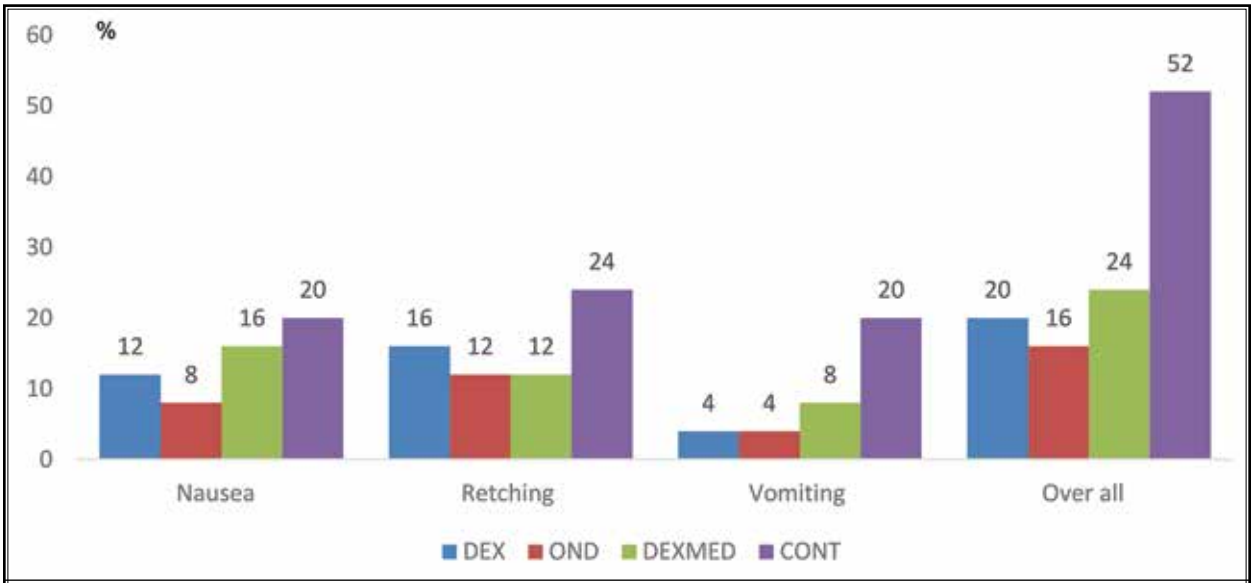

Fig. 2. *Number and percentage of patients who developed nausea, retching, vomiting and overall PONV among 4 groups(group DEX included patients who received dexamethasone; group OND included patients who received ondansetron: group DEXMED included patients who received dexmedetomidine and group CONT included patients who received saline).*

Table 3. *Number and percentage of patients who required rescue antiemetic.*

	DEX		OND		DEXMED		CONT		χ^2	*P* value
	N	%	N	%	N	%	N	%		
Number and percentage of patients requiring rescue antiemetic	2	8	1	4	3	12	9	36	12.157	0.007*
P1: 0.552, P2: 0.637, P3: 0.017*, P4: 0.297, P5: 0.005*, P6: 0.047*										

Data presented as the number and percentage of patients. Group DEX included patients who received dexamethasone; group OND included patients who received ondansetron; group DEXMED included patients who received dexmedetomidine and Group CONT included patients who received saline. (N) = Number of patients in each group; (%) = percentage. Data presented as mean ± standard deviation (SD). *P* value indicates the significance of the difference between groups: P1:DEX & OND. P2: DEX & DEXMED. P3: DEX & CONT. P4: OND & DEXMED. P5:OND & CONT. P6: DEXMED & CONT. * Denotes statistically significant difference ($P < 0.05$).

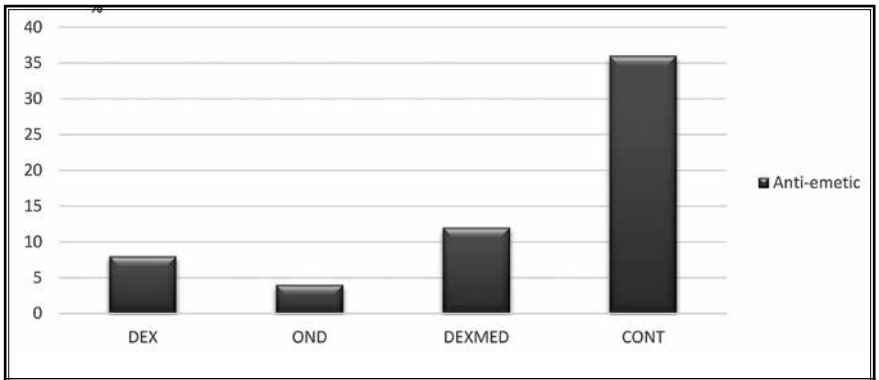

Fig. 3. *Percentage and number of patients who required rescue antiemetic among 4 groups(group DEX included patients who received dexamethasone; group OND included patients who received ondansetron: group DEXMED included patients who received dexmedetomidine and group CONT included patients who received saline).*

For the PAED scale, there was a marked statistically significant reduction in the scores in group DEXMED in comparison to the other groups in most of the time recordings. However, at T2 and T3 there was no significant difference between the DEXMED and DEX groups (P2 = 0.162, P2 = 0.068, respectively). Additionally, at T2 the scores were comparable between groups DEXMED and OND (P4 = 102). Moreover, group DEX and group OND were statistically

significantly reduced compared to group CONT (P3 = 0.001, P5 = 0.027, respectively) at T0. At T1, the scores were comparable in groups DEX, OND and CONT (P1 = 0.826, P3 = 0.288, P5 = 0.399, respectively). At T2, groups DEX and OND are statistically significantly reduced compared to group CONT (P3 = 0.001, P5 = 0.001, respectively) while there was no statistically significant difference between groups DEX and OND at T2 (P1 = 0.807). At T3, groups DEX and OND are statistically significantly reduced compared to group CONT (P3 = 0.001, P5 = 0.049, respectively) while there was no statistically significant difference between groups DEX and OND at T3 (P1 = 0.079) (Table 4).

We observed that the number of children who developed postoperative delirium agitation was markedly decreased in group DEXMED (one patient only) in comparison to groups DEX, OND and CONT (4, 7, and 10, respectively) with a statistical difference between them of $P = 0.015$ (Table 5) (Fig. 4).

We also observed that there was a reduction in POPS, group DEXMED in comparison to the other groups at all time points (15 minutes, 30 minutes, one, 2, and 4 hours postoperatively) with a statistical significance with an exception at 15 minutes and at hour 4, where there was no statistically significant difference between group DEXMED and group DEX (P2 = 0.194,

Table 4. *Pediatric Anaesthesia Emergence Delirium (PAED) scale in at 4 time points.*

PAED		Range			Mean	±	S. D	F test	*P* value	Post hoc test			
T0 At extubation	DEX	0	–	10	7.08	±	2.66	31.118	0.001*	P1	0.265	P4	0.001*
	OND	0	–	14	8.04	±	3.68			P2	0.001*	P5	0.027*
	DEXMED	0	–	4	2.04	±	0.89			P3	0.001*	P6	0.001*
	CONT	0	–	15	9.96	±	3.91						
T1 (5min) postextubation	DEX	0	–	16	10.92	±	4.14	24.066	0.001*	P1	0.826	P4	0.001*
	OND	0	–	16	11.16	±	4.52			P2	0.001*	P5	0.399
	DEXMED	0	–	6	3.92	±	1.63			P3	0.288	P6	0.001*
	CONT	0	–	17	12.08	±	4.33						
T2 (10 min) postextubation	DEX	0	–	9	5.04	±	2.21	11.418	0.001*	P1	0.807	P4	0.102
	OND	0	–	10	5.20	±	2.48			P2	0.162	P5	0.001*
	DEXMED	0	–	10	4.12	±	1.90			P3	0.001*	P6	0.001*
	CONT	0	–	11	7.76	±	2.59						
T3 (15 min) postextubation	DEX	0	–	7	4.08	±	2.02	11.576	0.001*	P1	0.079	P4	0.001*
	OND	0	–	8	5.04	±	1.99			P2	0.068	P5	0.049*
	DEXMED	0	–	5	3.08	±	1.35			P3	0.001*	P6	0.001*
	CONT	0	–	9	6.12	±	2.19						

Data presented as the number and percentage of patients. Group DEX included patients who received dexamethasone; group OND included patients who received ondansetron; group DEXMED included patients who received dexmedetomidine and Group CONT included patients who received saline. (N) = Number of patients in each group; (%) = percentage. Data presented as mean ± standard deviation (SD). *P* value indicates the significance of the difference between groups: P1:DEX & OND. P2: DEX & DEXMED. P3: DEX & CONT. P4: OND & DEXMED. P5:OND & CONT. P6: DEXMED & CONT. * Denotes statistically significant difference ($P < 0.05$).

Table 5. *Number and percentage of patients who developed delirium agitation.*

	DEX		OND		DEXMED		CONT		χ^2	*P* value
	N	%	N	%	N	%	N	%		
Number and percentage of patients developing delirium agitation	4	16	7	28	1	4	10	40	10.487	0.015*
P1: 0.306, P2: 0.157, P3: 0.059, P4: 0.021*, P5: 0.370, P6: 0.002*										

Data presented as the number and percentage of patients. Group DEX included patients who received dexamethasone; group OND included patients who received ondansetron; group DEXMED included patients who received dexmedetomidine and Group CONT included patients who received saline. (N) = Number of patients in each group; (%) = percentage. Data presented as mean ± standard deviation (SD). *P* value indicates the significance of the difference between groups: P1:DEX & OND. P2: DEX & DEXMED. P3: DEX & CONT. P4: OND & DEXMED. P5:OND & CONT. P6: DEXMED & CONT. * Denotes statistically significant difference ($P < 0.05$).

P2 = 0.316, respectively). On the other hand, at 15 minutes, 30 minutes, one hour and 2 hours, group DEX had a statistically significant lower POPS score than groups OND and CONT (P1 = 0.001, P1 = 0.001, P3 = 0.001, respectively). However, at the hour 4, there was no statistically significant difference between groups DEX and OND (P1 = 0.183). Likewise, group OND had statistically significant better scores than group CONT at 15 minutes and the hour 4 (P5 = 0.001). Additionally, there was no statistically significant difference between groups OND and CONT at 30 minutes, hour one and hour 2 (P5 = 0.230, P5 = 0.574, P5 = 542, respectively) (Table 6).

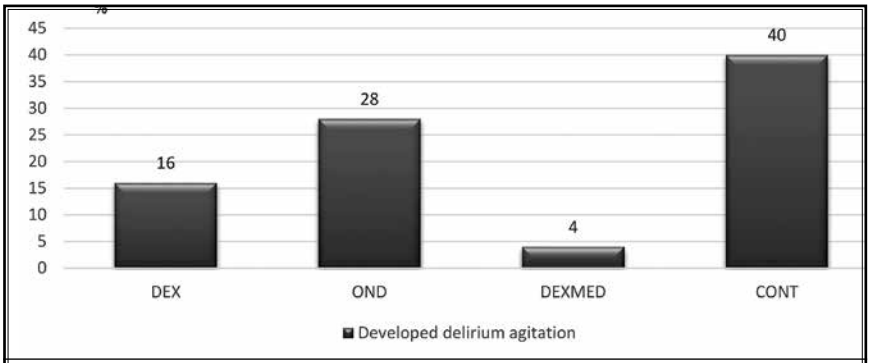

Fig. 4. *Percentage and number of patients who developed delirium agitation among 4 groups. (group DEX included patients who received dexamethasone; group OND included patients who received ondansetron: group DEXMED included patients who received dexmedetomidine, and group CONT included patients who received saline).*

In our study, no adverse events were reported in all groups such as hypotension, bradycardia, or an elevated blood glucose level in the first 24 hours postoperatively. Moreover, patients who required granisetron as a rescue antiemetic in the

Table 6. *Pediatric Objective Pain Scale (POPS).*

POPS		Range			Mean	±	S. D	F test	*P* value	Post hoc test			
15 minutes	DEX	0	–	4	1.80	±	1.29	45.309	0.001*	P1	0.001*	P4	0.001*
	OND	2	–	6	3.76	±	1.54			P2	0.194	P5	0.001*
	DEXMED	0	–	3	1.32	±	1.03			P3	0.001*	P6	0.001*
	CONT	3	–	7	5.08	±	1.29						
30 minutes	DEX	2	–	6	3.72	±	1.43	53.121	0.001*	P1	0.001*	P4	0.001*
	OND	4	–	8	5.76	±	1.33			P2	0.001*	P5	0.230
	DEXMED	0	–	4	2.16	±	1.18			P3	0.001*	P6	0.001*
	CONT	5	–	8	6.20	±	1.19						
One hour	DEX	3	–	6	4.48	±	1.05	47.991	0.001*	P1	0.001*	P4	0.001*
	OND	4	–	8	5.92	±	1.44			P2	0.001*	P5	0.574
	DEXMED	0	–	5	2.36	±	1.32			P3	0.001*	P6	0.001*
	CONT	5	–	8	6.12	±	1.17						
2 hours	DEX	3	–	8	4.88	±	1.30	40.617	0.001*	P1	0.001*	P4	0.001*
	OND	5	–	9	7.04	±	1.37			P2	0.002*	P5	0.542
	DEXMED	2	–	6	3.60	±	1.35			P3	0.001*	P6	0.001*
	CONT	5	–	9	7.28	±	1.51						
4 hours	DEX	4	–	9	5.76	±	1.42	13.427	0.001*	P1	0.183	P4	0.021*
	OND	5	–	9	6.24	±	1.39			P2	0.316	P5	0.001*
	DEXMED	4	–	8	5.40	±	1.22			P3	0.001*	P6	0.001*
	CONT	6	–	9	7.52	±	0.96						

Data presented as the number and percentage of patients. Group DEX included patients who received dexamethasone; group OND included patients who received ondansetron; group DEXMED included patients who received dexmedetomidine and group CONT included patients who received saline. (N) = Number of patients in each group; (%) = percentage. Data presented as mean ±standard deviation (SD). *P* value indicates the significance of the difference between groups: P1:DEX & OND. P2: DEX & DEXMED. P3: DEX & CONT. P4: OND & DEXMED. P5:OND & CONT. P6: DEXMED & CONT. * Denotes statistically significant difference ($P < 0.05$).

OND group did not show any complications like cardiac QT prolongation.

Discussion

In this randomized study, the number and percentage of children who developed PONV and required rescue antiemetics were significantly reduced in group DEXMED compared to the CONT group. However, these outcomes were comparable with groups DEX and OND.

During 24 hours of postoperative monitoring, the overall percentage of PONV was 24% in group DEXMED, which was significantly less than that in group CONT (52%). Moreover, the PONV percentage was 20% in group DEX and 16% in group OND.

Our finding is consistent with Gupta et al (20) who studied dexmedetomidine administration in pediatric vertebral column operations where PONV incidences were reduced significantly. Furthermore, Li et al (21) found that PONV development was reduced significantly without prolonged recovery periods when dexmedetomidine was given in pediatric strabismus surgery (21).

Xu et al (22) reported that a lidocaine/dexmedetomidine infusion after laparoscopic hysterectomy decreased the incidence of PONV decreased in the first 2 hours postoperative as will as 24 hours after surgery.

Another study parallels to our study. Bakri et al (23) reported that a single dose of dexmedetomidine has a positive effect on the incidence and severity of PONV and was similar to the dexamethasone's effect after laparoscopic cholecystectomy.

Many explanations may be considered for dexmedetomidine's effect on PONV. The opioid-sparing and inhaled anesthetics-sparing effects produced by dexmedetomidine may play a role in the prevention of PONV (24,25). Likewise, dexmedetomidine decreases sympathetic outflow and α^2 adrenoceptor presynaptic activity with a subsequent reduction in noradrenergic activity which may relate to PONV reduction (26).

Many studies have recommended 0.3–1.0 μg/kg dexmedetomidine after induction in pediatric surgeries (13-15). Additionally, it has been reported that 0.3 μg/kg dexmedetomidine has a positive impact on hemodynamics and recovery profiles in pediatric surgeries (27). Moreover, other studies have documented delayed extubation time and prolonged recovery periods with 1.0 μg/kg dexmedetomidine (28). In our study, we used 0.3 μg/kg dexmedetomidine by infusion based on previous reportings. However, the optimal dexmedetomidine dosage required for satisfactory antiemetic effects needs more studying and investigation.

In comparison, Lee et al (29) found that dexmedetomidine was not effective in decreasing PONV when compared to a general anesthesia group for nasal bone fracture surgery. Perhaps this finding was due to local anesthesia infiltration in the dexmedetomidine group together with the study of PONV in the PACU only.

Our current study reports a lower number of patients who required rescue antiemetics and a decreased granisetron dose in group OND than in other groups. Additionally, it was lower in group DEXMED compared to group CONT. This was the same as reported by Kwak H et al (30). Dexmedetomidine has many benefits as a sedative and analgesic in addition to its sympatholytic actions with little hemodynamic affection and no respiratory depression (24). PAED scores and the development of delirium agitation in this study were much lower in group DEXMED; this coincided with results reported by Ma et al (31).

Among the 3 medication groups, patients in group OND showed a higher number and percentage of delirium agitation and was comparable to that in group CONT. Similarly, Hoşten et al (32) showed that prophylactic ondansetron did not reduce emergence agitation in children scheduled for surgeries below the umbilicus. Contrarily, a systematic review conducted by Haque et al (33) showed that ondansetron may have a potential effect in reducing emergence agitation in elderly patients after cardiac surgery. However, studies were few and of poor quality.

POPS was much lowered in group DEXMED with a statistical significance, likewise conducted by Bakri et al (23).

Jain et al (34) studied the effect of intravenous glycopyrrolate on intraoperative as well as postoperative nausea and vomiting in women undergoing cesarean delivery under spinal anesthesia which was comparable to ondansetron injection but with an increased dry mouth incidence.

In this study, glycopyrrolate was given intramuscularly as a preanesthetic medication to all studied groups 30 minutes before induction of general anaesthesia; this could overcome the limitation of utilizing a control group without any prophylaxis without affecting the comparative nature of this randomized controlled study.

Conclusion

Dexmedetomidine has promising effects on reducing PONV and rescue antiemetic doses, along with a

reduction in pediatric emergence delirium and lower POPS scores with hemodynamic stability in children scheduled for dental rehabilitation procedures.

Limitations

Firstly, the optimal dexmedetomidine dosage for PONV reduction without any effects on patient hemodynamics and the best time of administration require more studies. Secondly, recruiting a control group without giving PONV prophylaxis; however, the use of glycopyrrolate and giving rescue antiemetics according to the BARF scale (above 4) mainly helped the investigators to overcome this limitation.

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