ORIGINAL ARTICLE

Dexmedetomidine versus fentanyl as adjuvant to propofol: comparative study in children undergoing extracorporeal shock wave lithotripsy

Ashgan Raouf Ali and Mohamed N. El Ghoneimy

Background The present study was designed to compare the efficacy, tolerability and safety of dexmedetomidine and fentanyl when combined with propofol during extracorporeal shock wave lithotripsy in children.

Methods Fifty children aged 3–8 years, the American Society of Anesthesiologists status I and II, scheduled for elective extracorporeal shock wave lithotripsy were randomly allocated to receive a loading dose 0.7 $\mu g\,kg^{-1}$ over 10 min followed by maintenance infusion 0.3 $\mu g\,kg^{-1}\,h^{-1}$ of either dexmedetomidine in propofol/dexmedetomidine group or fentanyl in propofol/fentanyl group ($n = 25$ each). The target drug infusion rates were adjusted to keep the haemodynamics within $\pm$ 20% from the baseline values. All patients received propofol infusion to maintain bispectral index values (40–60) throughout the procedure. Induction and maintenance doses of propofol were recorded. Total doses of both studied drugs were calculated. Perioperative haemodynamics, incidence of intraprocedural and postprocedural complications and time to first analgesic requirement were recorded.

Results The propofol requirement was significantly lower in the propofol/dexmedetomidine group than that in propofol/fentanyl group during induction and maintenance of anaesthesia ($P < 0.0001$). Total doses of fentanyl and dexmedetomidine were 0.961 (0.1) $\mu g\,kg^{-1}$ and 0.925 (0.07) $\mu g\,kg^{-1}$, respectively. Mean arterial pressure and heart rate were significantly decreased compared to the baseline throughout the procedure in both groups and increased significantly relative to both baseline and the other group at 30 min in the propofol/fentanyl group and 60 min in the propofol/dexmedetomidine group in the recovery area ($P < 0.05$). In propofol/dexmedetomidine group, the incidence of intraprocedural hypoventilation was significantly lower ($P = 0.016$) and time to first analgesic requirement was significantly longer ($P < 0.0001$) than that in propofol/fentanyl group.

Conclusion Both propofol/fentanyl and propofol/dexmedetomidine combinations at mentioned dose regimen were effective and well tolerated for children undergoing extracorporeal shock wave lithotripsy. However, propofol/dexmedetomidine combination was accompanied with less propofol consumption, prolonged analgesia and lower incidence of intraprocedural and postprocedural complications.

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Introduction

Extracorporeal shock wave lithotripsy (ESWL) has been successfully used in adults for nonsurgical removal of upper urinary tract calculi.[1] The study done by Newman *et al.*,[2] in 1986, was the first study using ESWL in paediatric patients. After that, a number of studies showing high success rate and minimal morbidity have increasingly proved ESWL as a therapeutic modality for childhood urolithiasis.[3,4]

Many different techniques have been used for pain relief and prevention of discomfort of paediatric patients during ESWL.[4] General anaesthesia is still the appropriate choice for patients younger than 5 years of age and for older patients who cannot cooperate well with the procedure and the analgesia technique.[1] Usage of general anaesthesia is also necessary to locate the stone successfully and to protect the adjacent organs, particularly in younger patients who may be less cooperative.[1]

Propofol is an intravenous sedative-hypnotic agent with amnestic properties that causes rapid and reliable loss of consciousness.[5] Because it is a poor analgesic, propofol usually requires the use of an adjunctive analgesic agent.[6] It may cause a dose-dependent respiratory depression, an effect that can be amplified in the presence of opioids.[7]

Dexmedetomidine is a highly selective α_2-adrenoceptor agonist that has sedative, analgesic, sympatholytic properties with little effect on ventilation.[8] Its intraoperative administration reduces anaesthetic requirements, speeds postoperative recovery and blunts the sympathetic nervous system response to surgical stimulation.[9] Although it has been used increasingly in children,[9–11] there was no previous report concerning its use in paediatric ESWL.

The present study was designed as a prospective, double-blinded, randomised, clinical study to compare the efficacy, tolerability and safety of dexmedetomidine and fentanyl when combined with propofol during ESWL in paediatric patients. We hypothesised that

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dexmedetomidine would decrease the propofol consumption and hence its dose-dependent side effects more efficiently than fentanyl.

Patients and methods

This study was conducted at Kasr El-Ainy hospital, Cairo University, from February 2006 to March 2008. Ethical approval for this study (Ethical Committee N° MERC 3/2006) was provided by the Medical and Ethical Research Committee, MERC of Anaesthesia Department – Cairo University Teaching Hospital, Cairo, Egypt (Approved by Professor M Fawzy) on 16 January 2006. Informed consents were obtained from parents of all children. Fifty paediatric patients of the American Society of Anesthesiologists (ASA) physical status I and II, aged 3–8 years, who were scheduled for elective ESWL, were enroled in this prospective, randomised, double-blinded study. All patients were preoperatively assessed by history, physical examination and laboratory investigations, including complete blood count (CBC), coagulation profile, renal function tests and serum electrolytes. Exclusion criteria included history of allergy to any of the study medications, current respiratory disorder, severe hepatic or renal impairment, severe cardiac dysfunction or airway abnormalities. All children fasted for a minimum of 6 h for solid food and 2 h for clear liquids.

Children were randomly allocated according to sealed envelope method to one of two groups, propofol/dexmedetomidine group and propofol/fentanyl group ($n = 25$ for each). Dexmedetomidine (Precedex; Abbott Laboratories, North Chicago, Illinois, USA) and fentanyl were diluted with 0.9% NaCl to a concentration of $2\,\mu g\,ml^{-1}$ in 50 ml. Both dexmedetomidine and fentanyl solution were prepared by anaesthesiology resident, who was blinded to the recorded data, and administered using syringe pump (Ascor syringe pump; Ascor S.A, Warsaw, Poland).

To facilitate intravenous (i.v.) catheter insertion, eutectic mixture of local anaesthetic (EMLA) cream was applied on dorsum of both hands 60 min before the procedure. On arrival to the ESWL unit, two 22-gauge intravenous catheters were inserted into the dorsum of hands, one for propofol infusion and the other for infusion of the second drug used. All patients were not premedicated.

Standard monitors, including ECG, noninvasive blood pressure and pulse oximeter were applied (Infinity SC 8000; Dräger Medical System, Danvers, Massachusetts, USA). In addition, standard BIS monitor strips (BISX; Aspect Medical Systems, Newton, Massachusetts, USA) were placed on the forehead. A bispectral index of 40–60 was considered the target range for surgical anaesthesia. BIS values were recorded before loading drug infusion (baseline or ($T0_{BIS}$), immediately after loading infusion of the target drug ($T1_{BIS}$) immediately after induction ($T2_{BIS}$) and every 15 min thereafter until the end of ESWL session ($T3_{BIS}$–$T5_{BIS}$).

The target drug infusions (dexmedetomidine or fentanyl) were started by a loading dose $0.7\,\mu g\,kg^{-1}$ over 10 min followed by maintenance infusion $0.3\,\mu g\,kg^{-1}\,h^{-1}$. After completion of the initial loading dose of either dexmedetomidine or fentanyl, all patients received propofol infusion, which was started at $100\,\mu g\,kg^{-1}\,min^{-1}$ and titrated to maintain the bispectral index at 40–60 throughout the procedure. To reduce propofol injection pain, 1 ml of 1% lidocaine was administered i.v. before propofol administration. The propofol dose required for induction was recorded.

After achievement of BIS value less than 60, a laryngeal mask airway (LMA) was inserted in all patients. The size of the LMA was chosen depending on patient's body weight. Satisfactory placement of the laryngeal mask was confirmed by chest auscultation. The presence of bilateral breath sounds and good quality air entry excluded downfolding of the epiglottis over the laryngeal inlet with consequent airway obstruction. The number of unsuccessful LMA insertion at first attempt in both groups was recorded.

All patients were spontaneously breathing 50% oxygen in air and a capnogram was attached to the anaesthetic circuit to obtain continuous measurement of end-tidal carbon dioxide ($ETCO_2$).

A Dornier Lithotripter (Doli-S) was used in all patients. After proper patient positioning, styrofoam boards were placed to provide both support and lung protection from the injury induced by shock waves. Stone localisation was done using either fluoroscopy or ultrasound guidance. An ungated technique was used with monitoring of heart rate (HR). Shockwave number ranged from 800 to 3650 (mean of 2500 shockwaves per session). All children underwent lithotripsy with a gradual incremental energy increase from 14 to 20 kV. All ESWL procedures were done by the same surgeon.

HR, mean arterial pressure (MAP) and respiratory rate were continuously monitored and recorded before loading drug infusion (baseline or (T0), immediately after induction (T1) and every 15 min thereafter until the end of ESWL session (T2-T4). The magnitude of changes of haemodynamics (MAP, HR) versus the baseline values were calculated at the same time intervals.

The infusion rates of dexmedetomidine and fentanyl were increased or decreased by $0.1\,\mu g\,kg^{-1}\,h^{-1}$ to maintain MAP and HR at $\pm$ 20% from the baseline value. Bradycardia ($HR < 60\,beats\,min^{-1}$) was treated by i.v. atropine $0.02\,mg\,kg^{-1}$.

Intraprocedural respiratory complications were recorded in both groups. If any patient developed desaturation ($Sp_{O_2} < 95\%$ for 30 s), apnoea (cessation of respiration >15 s) or hypoventilation ($ETCO_2 > 50\,mmHg$), the inspired O_2 concentration was increased to 100% and assisted bag ventilation was started. If no improvement

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Table 1 Objective Pain Score

Observation	Score
Blood pressure	
±10% of preoperative value	0
>20% of preoperative value	1
>30% of preoperative value	2
Crying	
Not crying	0
Crying, respond to TLC	1
Crying, does not respond to TLC	2
Movement	
None	0
Restless	1
Trashing around	2
Agitation	
Asleep or calm	0
Mild agitation	1
Hysterical	2
Verbalisation of pain	
Asleep, states no pain	0
Vague, cannot localise pain	1
Localises pain	2

TLC, tender loving care. Adapted from.[13]

had occurred, the infusion rate of dexmedetomidine or fentanyl was decreased gradually by 10% decrements.

At the conclusion of ESWL session, drug infusions were stopped. The total amount of propofol, dexmedetomidine and fentanyl administered during maintenance of anaesthesia were recorded.

After removal of the laryngeal mask, patients were transferred to the recovery area. MAP, HR and Sp_{O_2} were continuously monitored and recorded at arrival to the recovery area and every 15 min for 1 h postoperatively (T5-T9).

Postprocedural recovery was evaluated using a modified Aldrete score[12] every 5 min in the recovery room until full scoring was achieved. Postprocedural pain was assessed every 10 min in the recovery area using Objective Pain Scale (OPS)[13] (Table 1). Each criterion scored from 0–2 to give total score of 0–10. These observations were made in the presence of the patient's parents. Diclofenac (1–2 $mg\,kg^{-1}$) suppository was given if OPS $\geq$4. Time to the first rescue analgesic requirement was recorded in each group.

The occurrence of any postprocedural side effects (e.g. nausea, vomiting, haemodynamic instability, desaturation or apnoea) was also recorded and managed accordingly. Intravenous ondansetron (0.1 $mg\,kg^{-1}$) was given if nausea and vomiting had occurred.

Both recovery time and discharge time were recorded for all patients. Recovery time was defined as the period of time between discontinuation of study drug infusion and achieving of modified Aldrete recovery score of at least 9. Discharge time was defined as the time from the end of procedure until the child fulfilled the discharge criteria. The criterion of the discharge was the return of vital signs and level of consciousness to baseline, ability to ambulate without help and to tolerate clear fluid without nausea and vomiting.

The primary outcome of this study was assessing propofol requirement at induction and maintenance when anaesthesia was supplemented with dexmedetomidine or fentanyl in children undergoing ESWL.

Our sample size estimate was based on the expected differences in maintenance dose of propofol between the two groups. A previous study at our institution using the same surgical procedure in the same age group (unpublished results) indicated that maintenance dose of propofol when combined with fentanyl was 103.6 (17.2) $\mu g\,kg^{-1}\,min^{-1}$ [mean (SD)]. Assuming that a difference of 15% or more would be of clinical interest, a sample size of 23 patients per group was calculated to achieve a power of 85% and a significance level of 0.05. We, thus, made *a priori* decision to evaluate 25 patients in each group.

Statistical analysis

Data were presented as mean (SD), number (%) or median (25th–75th percentiles) as appropriate. Comparison between the two groups was performed using unpaired Student's *t*-test. Intragroup comparisons relative to baseline were performed using repeated measure analysis of variance (ANOVA) with post-hoc Dunnett's test if ANOVA results were significant. Categorical variables were compared using test of proportion. Nonparametric data were compared using Mann–Whitney *U*-test. A *P* value less than 0.05 was considered statistically significant.

Results

Sixty four patients were assessed for study eligibility (nine patients failed to meet the inclusion criteria and five patients, their parents, refused to sign the consent form). The remaining 50 patients who fulfilled the entry criteria were enroled in this study. All patients were able to complete the entire study and their data were included in the final analysis.

The two groups were comparable with respect to age, weight, sex, ASA physical status and duration of the procedure (Tables 2 and 3). The propofol requirement was significantly lower in the propofol/dexmedetomidine group than in propofol/fentanyl group during induction and maintenance of anaesthesia to maintain BIS value

Table 2 Demographic data of both groups [mean (SD) or ratio]

	PF group ($n=25$)	PD group ($n=25$)
Age (years)	5.3 (1.9)	5.6 (2.1)
Weight (kg)	21 (5.2)	23 (6.7)
Sex (male/female)	13/12	11/14
ASA (I/II)	23/2	22/3

ASA, American Society of Anesthesiologists; PD, propofol/dexmedetomidine group; PF group, propofol/fentanyl group.

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Table 3 Intraprocedural and postprocedural data [mean (SD)]

	PF group ($n=25$)	PD group ($n=25$)	P value
Duration of the procedure (min)	41.5 (3.6)	42.8 (4.1)	0.2393
Propofol requirement			
Induction dose (mg kg^{-1})	2.3 (0.19)	1.2 (0.06)	<0.0001
Maintenance dose (μg kg^{-1} min^{-1})	110.5 (5.2)	65.5 (6.4)	<0.0001
Total dose of dexmedetomidine (μg kg^{-1})	–	0.925 (0.07)	
Total dose of fentanyl (μg kg^{-1})	0.961 (0.1)	–	
Time to first analgesic requirement (min)	32.2 (3.1)	58.8 (4.3)	<0.0001
Recovery time (min)	24.3 (2.8)	25.2 (3.3)	0.3036
Discharge time (min)	110.8 (20.5)	118.4 (23.6)	0.2300

PD, propofol/dexmedetomidine group; PF group, propofol/fentanyl group.

between 40 and 60 throughout the procedure ($P<0.0001$; Table 3).

Comparing the two groups, there was no significant difference in BIS values at all time intervals (Table 4).

The two studied groups were comparable as regards the baseline values of MAP, HR and respiratory rate. After induction, the absolute values of MAP and HR decreased significantly from baseline that continued throughout the procedure in both groups ($P<0.05$), with no intergroup differences. The magnitude of these decreases in haemodynamics was within 10% from baseline values in both groups with no significant difference between the two groups ($P>0.05$). Only three patients in propofol/fentanyl group (12%) and two patients in propofol/dexmedetomidine group (8%) required reduction of infusion rate of fentanyl and dexmedetomidine, respectively ($P=0.325$). Eleven patients in propofol/fentanyl (44%) group versus five (20%) patients in propofol/dexmedetomidine group required increase in infusion rate of fentanyl and dexmedetomidine, respectively ($P=0.048$). No patients in both groups required atropine administration. Total doses of fentanyl and dexmedetomidine used in this study were recorded in Table 3.

At the recovery room, the absolute values of MAP were increased significantly at T7 in propofol/fentanyl group and at T8 and T9 in propofol/dexmedetomidine group, and HR was increased significantly at T7 in propofol/fentanyl group and at T9 in the propofol/dexmedetomidine group when compared to the other group and to the baseline values ($P<0.05$; Figs 1 and 2). In propofol/dexmedetomidine group, the magnitude of increase in MAP was 3.72 (0.4) % at T8 versus 8.41 (5.9) % at T9, whereas the increase in HR was 1.90 (4.9) % at T8 and 11.69 (6.0) % at T9. Comparing to the other group, the magnitude of increase in haemodynamics was significantly higher at T7 in propofol/fentanyl group ($P<0.0001$) and at T8 and T9 in propofol/ dexmedetomidine group ($P=0.0019$ and $P<0.0001$, respectively).

The number of unsuccessful LMA insertion at first attempt was comparable in both groups [3 (12%) in propofol/dexmedetomidine group versus 2 (8%) in propofol/fentanyl group, $P=0.325$].

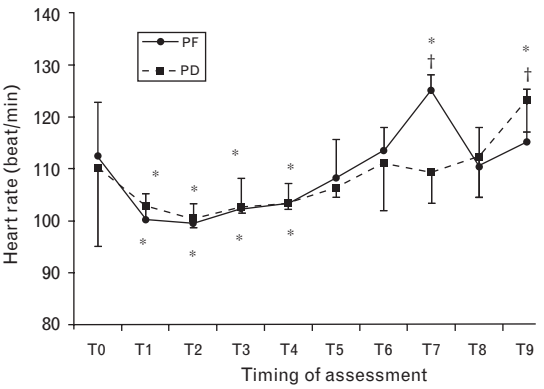
In the propofol/fentanyl group, the respiratory rate values were significantly lower than the baseline throughout the procedure. Compared to propofol/dexmedetomidine group, the intraprocedural respiratory rate values in propofol/fentanyl group were significantly lower at all time intervals ($P<0.05$). However, the propofol/dexmedetomidine group showed no intragroup significant differences in respiratory rate values throughout the procedure ($P>0.05$; Fig. 3).

Table 4 Bispectral index values [median (25th–75th percentiles)]

	PF group ($n=25$)	PD group ($n=25$)	P value (PF group versus PD group)
$T0_{BIS}$	98 (95–99)	97 (93–99)	0.49
$T1_{BIS}$	96 (94–98)	95 (94–98)	0.49
$T2_{BIS}$	50 (48–53)	51 (47–55)	0.1
$T3_{BIS}$	49 (44–53)	50 (46–53)	0.11
$T4_{BIS}$	47 (45–53)	48 (46–55)	0.53
$T5_{BIS}$	48 (44–54)	47 (45–54)	0.11

PD, propofol/dexmedetomidine group; PF group, propofol/fentanyl group. $T0_{BIS}$ = baseline, $T1_{BIS}$ = after infusion of loading dose of the target drug, $T2_{BIS}$ = after induction, $T3_{BIS}$–$T5_{BIS}$ = every 15 min during the procedure.

Fig. 1



Perioperative heart rate. Data points are means and error bars are SD. PF group = propofol/fentanyl group, PD = propofol/dexmedetomidine group. T0 = baseline, T1 = after induction, T2–T4 = every 15 min during the procedure, T5 = at arrival to the recovery area, T6–T9 = every 15 min at the recovery area. *=$P<0.05$ versus baseline value. †=$P<0.05$ versus the other group.

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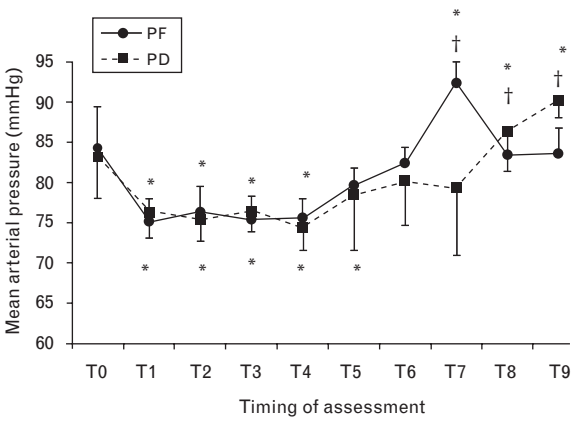
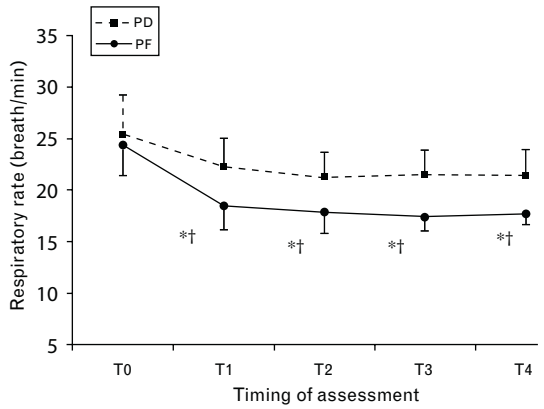
Fig. 2



Perioperative mean arterial pressure. Data points are means and error bars are SD. PF group = propofol/fentanyl group, PD = propofol/dexmedetomidine group. T0 = baseline, T1 = after induction, T2–T4 = every 15 min during the procedure, T5 = at arrival to the recovery area, T6–T9 = every 15 min at the recovery area. *=$P<0.05$ versus baseline value. †=$P<0.05$ versus the other group.

As regards the incidence of intraprocedural respiratory adverse effects, the number of patients who experienced hypoventilation was significantly higher in propofol/fentanyl group [9 (36%)] as compared with that in propofol/dexmedetomidine group [2 (8%)] ($P=0.016$), while desaturation occurred in three patients (12%) in propofol/fentanyl group versus one patient (4%) in propofol/dexmedetomidine group ($P=0.249$). There was not any apnoea episode recorded in both groups throughout the study period.

Fig. 3



Preoperative and intraoperative respiratory rate. Data points are means and error bars are SD. PF group = propofol/fentanyl group, PD = propofol/dexmedetomidine group. T0 = baseline, T1 = after induction, T2–T4 = every 15 min during the procedure. *=$P<0.05$ versus baseline value. †=$P<0.05$ versus the other group.

The incidence of postprocedural complications was comparable between the two groups except for nausea and vomiting, which were significantly higher in propofol/fentanyl group than in propofol/dexmedetomidine group [8 (32%) versus 2 (8%), respectively; $P=0.031$].

Time recorded to first analgesic requirement was significantly shorter in propofol/fentanyl group than in propofol/dexmedetomidine group ($P<0.0001$; Table 3).

Recovery times and discharge times were comparable in the two studied groups (Table 3).

Discussion

Safe and effective anaesthesia in paediatric patients during ESWL is a challenging task for anaesthesiologists. Although it requires minimal to no sedation/analgesia in adults, it is difficult for paediatric patients to tolerate the procedural pain and keep motionless.[14] In the present study, a mixture of propofol/fentanyl and that of propofol/dexmedetomidine were studied in order to achieve better quality of anaesthesia and reduce the total dose of anaesthetics and hence, the side effects.

The pathogenesis of pain in ESWL is considered to be multifactorial. The cutaneous superficial skin nociceptors and visceral nociceptors are two important components responsible for causing pain during ESWL.[15] Patient-related factors and several physical variables, including the type of lithotripter, size and site of stone burden, shockwave peak pressure and size of focal zone are additionally responsible for pain.[16]

As a result of upgrading the original Lithotripter, a Wolf Piezolith 2300 with a Dornier lithotripter, most children required general anaesthesia. The column of energy in the former lithotripter is wide and does not cause much discomfort during treatment.[17] The Dornier lithotripter, which was used in this study, uses an electromagnetic source to generate the shockwaves and an acoustic lens focuses them on the stone, so the column of energy is much more focused causing increased discomfort during treatment.[17]

The analgesic regimen of the current study was designed to administer the studied drugs as a loading dose followed by maintenance infusion. The rate of infusion was modified according to changes in haemodynamics to adjust the proper analgesic dose required during ESWL in children. The mean total dose of fentanyl required in this study was 0.961 (0.1) $\mu g\,kg^{-1}$. This finding coincides with results of previous studies investigating the use of $1\,\mu g\,kg^{-1}$ fentanyl at induction during ESWL.[14,18–20]

The BIS monitor can serve as a useful objective tool to guide the safe and effective titration of anaesthetics for children older than 2 years.[21–23] BIS-guided anaesthetic management was associated with a significant reduction in anaesthetic use, earlier emergence and shorter recovery in this population.[21,24] In the present study, BIS was

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used in order to guide the titration of propofol to achieve adequate level of hypnosis and to differentiate between inadequate anaesthesia and lack of analgesia in children aged 3–8 years.

The induction and maintenance doses of propofol were reported in this study to be lower in propofol/dexmedetomidine group than propofol/fentanyl group. These results could be postulated to the anaesthetic sparing effects of dexmedetomidine, which was reported in many previous clinical studies.[25,26]

The haemodynamic effects of α2-agonists are thought to be a combination of their central sympatholytic and peripheral vasoconstrictive effects.[27] Dexmedetomidine, like other α_2-agonists, displays a biphasic, dose-dependent blood pressure response. High bolus doses initially result in a transient increase in blood pressure and a reflex decrease in HR followed by a decrease in blood pressure.[28] In the current study, a loading dose of i.v. $0.7\,\mu g\,kg^{-1}$ dexmedetomidine, infused over 10 min, was chosen to avoid its initial effects in blood pressure. As the dexmedetomidine package insert recommends a maintenance infusion of $0.2–0.7\,\mu g\,kg^{-1}\,h^{-1}$, we started with small dose $0.3\,\mu g\,kg^{-1}\,h^{-1}$ to avoid untoward haemodynamic effects of dexmedetomidine.

In the present study, despite the significant reduction in haemodynamic parameters (MAP and HR) throughout the intraprocedural period in both groups, this reduction was within 10% from baseline values, which is not clinically important.

In accordance with these results, Kaygusuz *et al.*[20] reported significant reduction in MAP values compared to baseline when they used propofol/fentanyl for sedation during ESWL procedure in adults.

Other previous studies reported that dexmedetomidine produced either reduction of HR only[29] or both HR and MAP[30] in children undergoing radiological procedures. The reduction was clinically acceptable for the paediatric age group, which coincides with the results of the present study.

As regards the pharmacodynamic effects of propofol, it causes a dose-dependent respiratory depression and airway obstruction.[6]

The effect of dexmedetomidine on respiratory rate is controversial. Hsu *et al.*[31] had reported a significant increase in respiratory rate with dexmedetomidine, whereas Belleville *et al.*[32] and Kaygusuz *et al.*[20] reported a significant decrease in respiratory rate. Some authors have reported that dexmedetomidine did not affect respiratory rate, Spo_2 and $ETCO_2$.[33,34] This discrepancy could be related to different regimen of administration.

In the current study, significantly lower respiratory rate and higher incidence of intraprocedural hypoventilation in propofol/fentanyl group (36%) compared to (8%) that in propofol/dexmedetomidine group could be explained by the higher induction and maintenance doses of propofol required in the propofol/fentanyl group. In addition, the effect of fentanyl should be considered to affect respiratory function as reported by many previous studies.[14,20,35]

The incidence of desaturation was 12% and that of hypoventilation was 36% in propofol/fentanyl group versus 4 and 8% in propofol/dexmedetomidine group, respectively. However, these complications were transient and treated with increasing the inspired oxygen concentration and assisted bag ventilation. None of the patients developed apnoea or required reduction in drug infusion rates or mechanical ventilation.

In accordance, Godambe *et al.*,[6] who used a combination of propofol and fentanyl for brief orthopaedic procedural sedation, reported transient desaturation in 31% of patients with 25% of them requiring supplemental oxygen and no patients developed apnoea.

Erden *et al.*[14] reported that usage of propofol/fentanyl for children during ESWL resulted in higher incidence of intraoperative desaturation (85%) and apnoea (75%). The discrepancies between the results of the present study and those of Erden's study may be attributed to the differences in the methodology. Laryngeal mask was used in this study to avoid the deleterious effect of airway obstruction and capnography was also used to detect hypoventilation earlier than clinical assessment and pulse oximetry as stated in previous study done by Miner *et al.*[36]

Concerning the postprocedural analgesia in the current study, the mean time recorded to first analgesic requirement was significantly shorter in propofol/fentanyl group than propofol/dexmedetomidine group. These findings coincided with the changes that occurred in MAP and HR postoperatively. This could be explained by fading of analgesic effect of fentanyl in propofol/fentanyl group and the prolonged analgesic effect of dexmedetomidine in propofol/dexmedetomidine group.

The prolonged postoperative analgesia demonstrated in propofol/dexmedetomidine group in this study is in accordance with that in the study by Gurbet *et al.*[37] who stated that intraoperative infusion of dexmedetomidine reduces perioperative analgesic requirements. Another study done by Aho *et al.*[38] demonstrated the analgesic properties of dexmedetomidine when used as a single agent after minor surgery.

The incidence of postprocedural complications in the current study was comparable in both groups except for nausea and vomiting, which was significantly higher (32%) in propofol/fentanyl group than propofol/dexmedetomidine group (8%). This could be explained by the emetic effect of fentanyl[39] or may be related to the postoperative renal pain, which was experienced earlier

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in propofol/fentanyl group than propofol/dexmedetomidine group.[17]

The comparable recovery time and discharge time recorded in our study is consistent with the results of the study done by Turgut *et al.*[40] who compared dexmedetomidine with fentanyl as an adjuvant to propofol during lumber laminectomy.

In conclusion, both propofol/fentanyl and propofol/dexmedetomidine combinations at prescribed dose regimen were effective and well tolerated for paediatric patients undergoing ESWL. However, propofol/dexmedetomidine combination was accompanied with less propofol consumption and lower incidence of intraprocedural respiratory complications and postprocedural nausea and vomiting, in addition to better postprocedural analgesia than propofol/fentanyl combination.

Future studies are needed to compare the efficacy of dexmedetomidine with other commonly used agents during ESWL in paediatrics.

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