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Research Article

# Efficacy of dexmedetomidine addition to bupivacaine on the quality of blind fascia iliaca compartment block in children undergoing femur fracture surgery

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## KEYWORDS

Fascia iliaca block;  
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Fracture femur

**Abstract** Efficacy of dexmedetomidine addition to bupivacaine on the quality of blind fascia iliaca compartment block in children undergoing femur fracture surgery.

**Objectives:** The objectives of this study were designed to detect the effects of addition of dexmedetomidine to bupivacaine on the quality of blind fascia iliaca compartment block and its possible side effects in children undergoing fracture femur surgery.

**Methods:** This study was conducted on 28 children (2–6 years of age), scheduled for fracture femur surgery. Children were randomly allocated to receive either 0.25% bupivacaine 1 ml kg<sup>-1</sup> (B group), or 0.25% bupivacaine 1 ml kg<sup>-1</sup> with dexmedetomidine 2 µg kg<sup>-1</sup> (BD group). Anesthesia was maintained with sevoflurane 1–1.5 minimum alveolar concentration. Intraoperative sevoflurane concentration, hemodynamic, postoperative emergence delirium, sedation scores and pain scores were recorded. Duration of surgery and emergence time were recorded. Postoperative complications such as (nausea and vomiting, respiratory depression, purities, hypotension and bradycardia) were reported.

**Results:** Compared to the group B, patients received bupivacaine–dexmedetomidine for fascia iliaca compartment block had lower intraoperative sevoflurane concentration, higher sedation score, longer duration of postoperative analgesia, less use of rectal paracetamol for the first 24 h postoperatively and less number with postoperative agitation. No patients developed postoperative respiratory depression, purities, hypotension or bradycardia.

**Conclusion:** The present study concluded that the combined use of bupivacaine–dexmedetomidine for fascia iliaca compartment block in children provided significant reduction of end-tidal sevoflurane

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concentration, remarkable hemodynamic stability, significant postoperative analgesia with lower postoperative analgesics requirements without any undesirable complications.

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## 1. Introduction

Fractures of the shaft of femur are common in children, especially isolated fractures of the mid-third of the femur which are intensely painful. Pain of the fracture is thought to originate from the femoral shaft periosteum and muscle spasm from the quadriceps [1].

Fascia iliaca compartment block is an easy and simple technique, requiring neither high-skill nor expensive equipments [2].

Dexmedetomidine is a highly selective  $\alpha_2$  agonist with high affinity for  $\alpha_2$  adrenergic receptors and less  $\alpha_1$  effects, which is responsible for the hypnotic and analgesic effects [3]. Previous trials demonstrated that perineural dexmedetomidine in combination with bupivacaine enhanced sensory and motor block, without neurotoxicity, in both experimental and clinical studies [4–7].

To our best knowledge, there is no available study of the efficacy of bupivacaine–dexmedetomidine for fascia iliaca compartment block.

We hypothesized that the use of combined bupivacaine–dexmedetomidine for fascia iliaca compartment block would lengthen the duration of postoperative analgesia (primary outcome objective). Secondary outcomes included sevoflurane requirements, quality of postoperative analgesia, postoperative sedation, delirium, hemodynamic and possible side effects in those children.

The present study was designed to test the effect of combined use of bupivacaine–dexmedetomidine for fascia iliaca compartment block on the duration and quality of postoperative analgesia as a primary objective, postoperative sedation, delirium, pain scores, sevoflurane requirements, hemodynamics, and possible side effects in children undergoing fracture femur surgery as a secondary objective.

## 2. Patients and methods

This prospective, randomized, blind study was approved by the local ethics committee and informed written consent was obtained from parents of the enrolled children, the study was registered at [www.clinicaltrials.gov](http://www.clinicaltrials.gov).

Twenty eight ASA I or II children aged from 2 to 6 years, underwent surgery for fracture femur at Mansoura Emergency Hospital, Egypt. Exclusion criteria included patients with known allergy to the study drugs, coagulopathy, infection at the site of the block, neurological diseases and history of developmental delay.

Patients were premedicated with oral midazolam  $0.5 \text{ mg kg}^{-1}$ , 1 h prior to induction. Upon arrival to the operating theatre, the child was monitored for ECG, heart rate (HR), noninvasive blood pressure (MAP) and pulse oximetry (SaO<sub>2</sub>) and values were recorded. Induction of anesthesia was achieved by inhaled sevoflurane at increasing concentration from 1% to 5% in 100% O<sub>2</sub>. Laryngeal mask airway with appropriate size for body weight was introduced and an intravenous catheter was inserted.

In all patients, general anesthesia was maintained with inhalation of sevoflurane 1–1.5 MAC (minimum alveolar concentration) in 40% air/oxygen mixture to maintain HR and MAP within 20% of their baseline values. A rescue dose of fentanyl  $0.5 \mu\text{g kg}^{-1}$  was given if HR or MAP remained above 20% of the basal values with sevoflurane exceeding 1.7 MAC.

Children were randomly allocated using computer software generated randomization code included in an opaque closed enveloping into one of two groups, 14 patients in each. Group B, in which children received  $1 \text{ mg kg}^{-1}$  bupivacaine 0.25%, or group BD in which children received  $1 \text{ mg kg}^{-1}$  bupivacaine 0.25% with dexmedetomidine  $2 \mu\text{g kg}^{-1}$ . The study solutions were delivered in 20 ml saline in similar syringes.

Fascia iliaca compartment block was performed pre-incision (after induction of anesthesia and before surgery) as described by Dalens et al. [8]. A 25-gauge spinal needle or axillary nerve block needle was inserted with an angle of  $45 \pm 60^\circ$  with the skin at  $(0.5 \pm 1 \text{ cm})$  below the inguinal crease at the junction of the medial two-thirds and lateral one-third of the line between the pubic tubercle and anterior superior iliac spine. The needle was advanced until the perception of two losses of resistance (pops) were noted which correspond to the crossing of fascia lata and then fascia iliaca injection proceeded after aspiration.

Anesthesiologist who provided the perioperative management and performed the fascia iliaca compartment block was blinded to the study solutions and the patients randomization, another independent investigator was involved in the collection of the patients' data.

Intraoperative hypotension requiring a fluid bolus and bradycardia requiring atropine were recorded. MAC of sevoflurane was recorded every 15 min till the end of operation. Heart rate, mean arterial blood pressure and oxygen saturation were recorded before surgery (baseline values) and every 20 min until the end of surgery, then at 1 h, 6 h, 12 h and 24 h postoperatively.

Postoperative analgesia was achieved by rectal paracetamol  $50 \text{ mg kg}^{-1}$  every 6 h and oral diclofenac  $0.5 \text{ mg kg}^{-1}$  on demand.

Emergence delirium was assessed using a scale described by Watacha et al. [9] while sedation was assessed using Ramsay's sedation scale [10] and postoperative pain was assessed using the Objective Pain Scale (children <6 year) which described by Hannallah et al. [11].

Postoperative sedation and pain scores were recorded at the end of surgery and then every 4 h for the first 24 h after surgery.

The duration of postoperative analgesia (from the time of extubation till the first use of rescue analgesic and the total used doses of paracetamol were recorded.

Emergence time (time from the end of surgery to opening the eyes on calling) was recorded. Postoperative complications such as nausea and vomiting (PONV), respiratory depression, purities, hypotension and bradycardia were reported. Respiratory depression was defined as a decrease in SpO<sub>2</sub> of less than

90% requiring supplementary oxygen. Hypotension was defined as systolic arterial pressure 70 plus twice the age in years and associated with altered peripheral perfusion, bradycardia was defined as HR below 80 beats/min.

Delayed anesthetic emergence was defined as 20 min elapsing from the end of surgery to exiting the operating theatre.

### 3. Statistical analysis

Data were analyzed using SPSS program (Statistical Package of Social Science) version 17.0 (SPSS Inc., Chicago, IL, USA). Kolmogorov–Smirnov (KS) test was done to assess normality of quantitative data. Numerical variables were presented as mean and standard deviation (SD) or median and interquartile range (IQR) as appropriate. Categorical data were summarized as frequency (percentages). Parametric data were analyzed by Student's *t*-test for in between-groups comparisons. Non-parametric data (pain, emergence delirium, sedation scores) were analyzed by Mann–Whitney test. For comparing categorical data, Chi-square ( $\chi^2$ ) test. *P*-value of  $\leq 0.05$  was considered significant and a *P* value of  $\leq 0.001$  was considered highly significant at 95% confidence.

Sample size estimation to detect an effect size of 25% between the control and treatment groups in the primary outcome parameter (duration of postoperative analgesia) assuming a power of 90.10% were added to the proposed sample to compensate for the drop out during the study requiring 14 patient per group.

### 4. Results

The studied groups were comparable as regard their age, sex, body weight, duration of surgery, duration of anesthesia and emergence time (Table 1). As regard hemodynamic parameters, there were no significant differences in mean arterial blood pressure and heart rate pre-operative, intra-operative and post-operative in between the studied groups (Figs. 1 and 2).

As regard SpO<sub>2</sub> pre-operative, intra-operative and post-operative there were no significant differences between the studied groups, none of the children required treatment for hypotension, bradycardia or hypoxemia. There was no failure in fascia iliaca block.

Compared to the group B, patients received bupivacaine–dexmedetomidine for FIC had lower intraoperative sevoflurane concentration and higher sedation scores with *P*-value less than 0.05 value (Figs. 3 and 4).

Paired student's *t*-test for in between groups comparison showed highly significant prolonged duration of analgesia and less number of declorfenac for the first 24 postoperative hours in group BD in comparison to group B with *P*-value  $< 0.001$  (Table 2).

Hanallahh pain score was significantly lower in group BD than group B at 24 h postoperatively (Table 3). BD group had higher percentage of patient with no agitation than B group, at confidence interval 95% of patient who had scores 0, 1, 2 95% (70%–15%–10%) in BD group compared with 40% (20%–10%–10%) in group B with *P*  $< 0.05$  (Fig. 5).

One patients in B group had vomiting (single attack and not need any medication). No patient developed postoperative respiratory depression, purities, hypotension or bradycardia.

### 5. Discussion

The results of the current study show that, the addition of dexmedetomidine to bupivacaine in fascia iliaca block was significantly increased the duration of postoperative analgesia, sedation score, reduction of intraoperative sevoflurane concentration, pain scores and analgesic requirements for 24 h postoperatively. Additionally, the group that received dexmedetomidine in fascia iliaca compartment block had no intraoperative or postoperative complications such as hemodynamic instability, respiratory depression, postoperative nausea and vomiting (PONV), or purities.

Fascia iliaca compartment block was performed for the first time in children in 1989. It was mainly used for postoperative pain relief (hip, femur and knee) but also in treatment of pain as the result of thigh burn or femur fracture [12]. Single shot of fascia iliac compartment block provides effective analgesia but for mean of 5 h for painful procedures affecting the femur, it blocks the three main lumbar plexus nerves blocking include femoral nerve, obturator nerve and, the lateral cutaneous nerve of the thigh by the central spread of local anesthetics (volume dependent block) [2].

Dexmedetomidine is a short acting highly selective  $\alpha_2$  agonist which has preserved respiratory function even with high doses of sedation and analgesia [13].

Although its elimination half-life is short (2–3 h), the analgesic-sparing effect observed after a preoperative or an intra-operative administration usually lasts up to 24 h, with the anxiolytic, sedative, and thymoanaleptic properties implicated as being partly responsible for this effect [14].

Interestingly, dexmedetomidine seems to possess neuroprotective effects and attenuates neurocognitive impairment

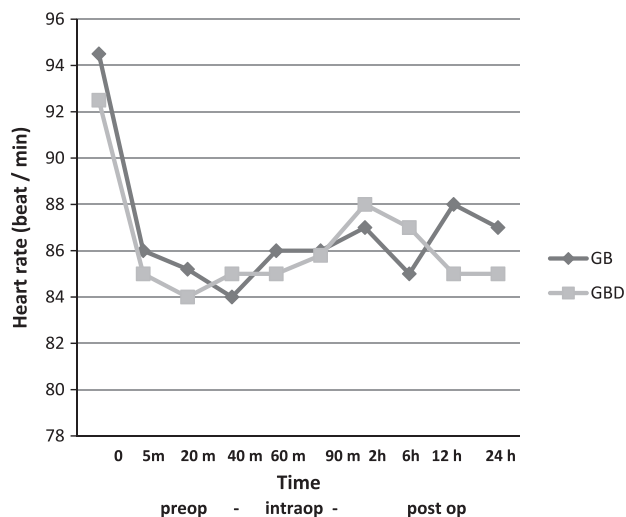
**Table 1** Patients characteristics, duration of surgery (min) and anesthesia (min) and emergence time (min) (Mean  $\pm$  SD).

Variable	Group B ( <i>n</i> = 14)	Group BD ( <i>n</i> = 14)	<i>P</i> -value
Age (years)	4.2 $\pm$ 1.4	4.3 $\pm$ 1.5	0.85
Weight (kg)	16.4 $\pm$ 2.8	16.3 $\pm$ 3	0.92
Sex (F/M)	4/10	5/9	0.68
ASA I/II (%)	11/3	12/2	0.62
Duration of surgery (min)	77.7 $\pm$ 9.3	79.6 $\pm$ 8.6	0.57
Duration of anesthesia (min)	98.3 $\pm$ 3.8	100.2 $\pm$ 4	0.2
Emergence time (min)	6.3 $\pm$ 4.6	7.2 $\pm$ 3.9	0.58

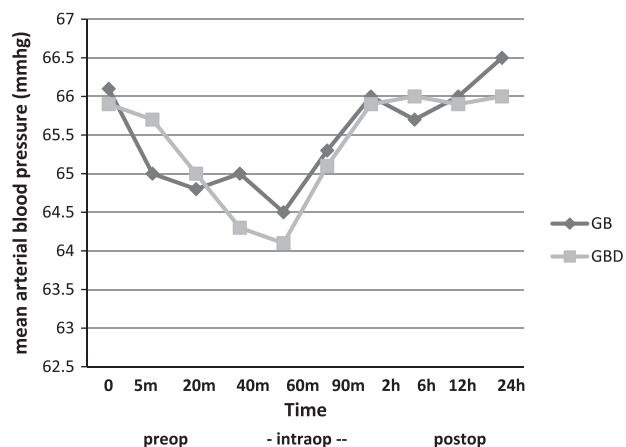
Group B = bupivacaine group.

Group BD = bupivacaine–dexmedetomidine group. *n* = number.

No statistical difference between the two studied groups.



**Figure 1** Heart rate, both groups were statistically comparable in the pre-op, intra-op and post-op hemodynamic changes without any therapeutic interventions. 0 (pre-op), 5 m (5 min after induction), 20 m (20 min after induction), 40 m (40 min after induction), 60 m (60 min after induction), 90 m (90 min after induction), 2 h (2 h postop), 6 h (6 h postop), 12 h (12 h postop), 24 h (24 h postop).

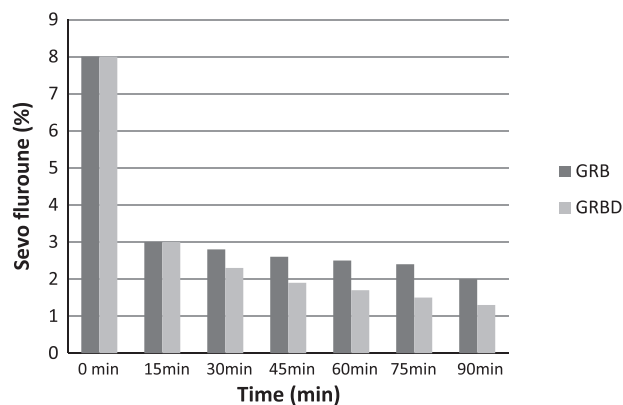


**Figure 2** Mean arterial blood pressure, both groups were statistically comparable in the pre-op, intra-op and post-op hemodynamic changes without any therapeutic interventions. 0 (pre-op), 5 m (5 min after induction), 20 m (20 min after induction), 40 m (40 min after induction), 60 m (60 min after induction), 90 m (90 min after induction), 2 h (2 h postop), 6 h (6 h postop), 12 h (12 h postop), 24 h (24 h postop).

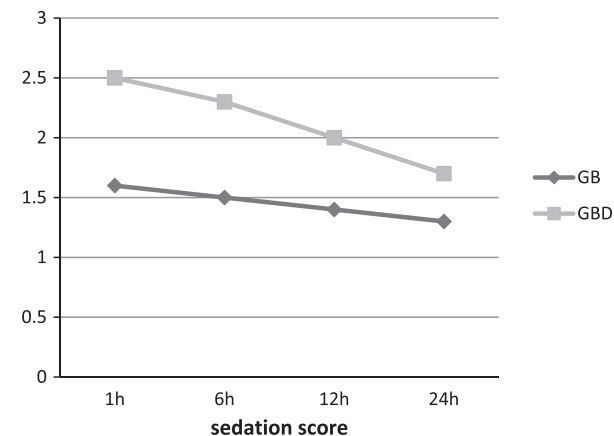
(mainly delirium and agitation) following anesthesia, and this in parallel with the result of the current study [15].

Dexmedetomidine has been used successfully to improve the quality and intensity of regional anesthesia block [16].

The mechanism by which dexmedetomidine improve the peripheral nerve block characteristic of the local anesthetics solutions is not clear [4]. Peripherally, through its selective action on  $\alpha_2$  adrenergic receptor agonists produce analgesia by reducing release of norepinephrine and blocking c and A-delta fibers and increase potassium conduction in neurons (inhibition



**Figure 3** Intra operative end-tidal sevoflurane (%) was significantly reduced in BD group compared with B group and in both groups compared with the basal values of each group.



**Figure 4** BD group had statistically significant higher postoperative sedation score than B group  $P < 0.05$ .

of the action potential), centrally  $\alpha_2$  agonists produce analgesia and sedation by inhibition of substance P release in the nociceptive pathway at the level of the dorsal root neuron and by activation of  $\alpha_2$  adrenoceptors in the locus coeruleus [17].

Animal and clinical studies reported that the addition of dexmedetomidine to local anesthetic solutions improved peripheral nerve blocks by reducing the onset time, extending postoperative analgesia, and improving the efficacy of nerve block during surgery with no recorded neurotoxicity [18].

In parallel with the main result of the current study on the duration of analgesia and analgesic requirements postoperatively, previous study such as El-Hennawy et al., reported that the addition of dexmedetomidine as adjuvant to bupivacaine or ropivacaine caudally in pediatrics were significantly increased the duration of postoperative analgesia without any undesirable side effects, the median duration of postoperative analgesia in patient received caudal dexmedetomidine-bupivacaine combination was 16 h [19].

Supporting the study results, Obayah et al. reported that the addition of dexmedetomidine to bupivacaine for greater palatine nerve block prolongs postoperative analgesia after cleft palate repair for about 50% [20].

**Table 2** Duration of analgesia (hours) and number of declofenac doses (mean  $\pm$  SD).

Variable	Group B ( <i>n</i> = 14)	Group BD ( <i>n</i> = 14)	<i>P</i> -value
Duration of analgesia (hours)	4.4 $\pm$ 0.5	15.9 $\pm$ 0.9	< 0.001***
Number of declofenac doses	3.3 $\pm$ 1.1	1.5 $\pm$ 0.8	< 0.001***

Group B = bupivacaine group.

Group BD = bupivacaine–dexmedetomidine group. *n* = number.

\*\*\* Significantly prolonged duration of analgesia and less number of declofenac in group BD in comparison to group B.

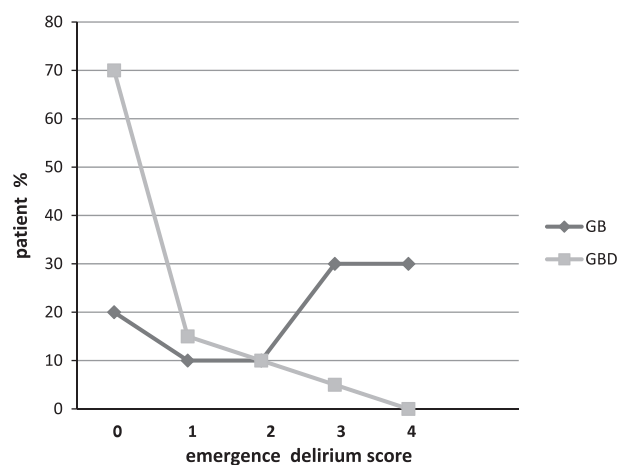
**Table 3** Hanallahh objective pain score (median and IQR interquaterial rang) and *P* < 0.05 significance.

	Group B ( <i>n</i> = 14)	Group BD ( <i>n</i> = 14)	<i>P</i> -value
Immediate postop (0)	1 (0–3)	0 (0–1) <sup>#</sup>	0.012
4 h Postop	1 (0–4)	0 (0–1) <sup>#</sup>	0.013
8 h Postop	2 (0–4)	0.5 (0–2) <sup>#</sup>	0.006
12 Postop	2 (1–4)	1 (0–2) <sup>#</sup>	0.010
18 h Postop	2.5 (1–4)	1.5 (0–3) <sup>#</sup>	0.028
24 h Postop	3 (1–4)	2 (0–3) <sup>#</sup>	0.034

Group B = bupivacaine group.

Group BD = bupivacaine–dexmedetomidine group. *n* = number.

<sup>#</sup> Significantly different from other group (0.05).



**Figure 5** Emergence delirium score, BD group had higher percentage of patient with no agitation than B group. At confidence interval 95% of patient who had scores 0, 1, 2 95% (70%–15%–10%) in BD group compared with 40% (20%–10%–10%) in group B. *P* < 0.05.

Also Saadawy et al., reported that caudal dexmedetomidine in pediatric seems to be a promising adjunct to provide excellent analgesia without side effects over 24 h period, it decreased end tidal sevoflurane concentration and the incidence of agitation, the duration of analgesia was prolonged, the total consumption of rescue analgesic was decreased [21].

Additionally, Anand et al. documented that caudally administered dexmedetomidine was significantly prevent the agitation and increased mean sedation score [22].

## 6. Conclusion

The current study found that dexmedetomidine seems to be a promising and effective adjuvant for blind fascia iliaca com-

partment block in children with femur fracture. It provided significant reduction of end-tidal sevoflurane concentration, remarkable hemodynamic stability, significant postoperative analgesia with lower postoperative analgesics requirements without any undesirable complications.

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