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ORIGINAL ARTICLE

Addition of Dexmedetomidine to Bupivacaine in Ultrasound Guided Erector Spinae Plane Block for Neonates Undergoing Tracheoesophageal Fistula Repair

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Background Assessing the effects of combining dexmedetomidine with bupivacaine in ultrasound-guided ESPB on the stress response and postoperative pain in infants having tracheoesophageal fistula surgery. The study evaluate the impact on the incidence of postoperative respiratory complications, the length of hospital stay, and the need for additional analgesics.

Settings and Design A prospective randomized study.

Methodology With institutional Medical Ethics Committee approval, this study was conducted at El-Shatby Paediatric Hospital on 90 neonates undergoing tracheoesophageal fistula repair. The neonates were divided into two equal groups at random: Group 1 received an ultrasound-guided ESPB with 0.25% bupivacaine (0.5ml/kg) and dexmedetomidine (0.5μg/kg), while Group 2 received ESPB with just 0.25% bupivacaine at the same volume.

Results Group 1's postoperative pain scores were consistently lower than Group 2's during the first 24 hours after surgery. After surgery, salivary cortisol levels rose in both groups, but there was no discernible difference. In addition, compared to Group 2, Group 1 showed a significant decrease in opioid use and a longer duration of analgesia. In Group 1, the duration of stay in the NICU was considerably shorter.

Conclusion Dexmedetomidine added to local anesthetics improved postoperative analgesia, prolonged the duration of pain relief, and reduced the need for additional opioids without causing major side effects, according to this study. These findings backed up the use of dexmedetomidine as a secure and useful adjuvant in pediatric regional anesthesia.

Keywords Dexmedetomidine, Erector spinae plane block, Neonatal infant pain scale, Salivary cortisol level, Tracheoesophageal fistula.
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INTRODUCTION

In newborns undergoing painful procedures, there are clear signs of discomfort that fall into two categories: physiological changes, such as changes in heart rate, respiratory rate, blood pressure, oxygen saturation (SaO_2), vagal tone, palmar sweating, and elevated plasma levels of cortisol and catecholamines, and behavioral indicators, such as facial grimacing, body movement, and crying[1,2]. These reactions offer crucial clinical indicators for assessing and treating neonatal pain and stress[3].

Neonates may experience severe enough pain and anxiety-related stress and agitation during the postoperative phase to put them at risk of dislodging from vital medical equipment[1]. Any physical, chemical, or emotional factor

that causes tension in the body or mind and may pave the way for the onset of disease is considered stress[4].

Although stress does not always involve pain, pain is inherently stressful, and both need to be appropriately identified and managed. Given that neonates and non-verbal infants communicate their pain through non-verbal cues[4,5]. physicians have created observational instruments to help with pain assessment. These instruments can be multidimensional (combining behavioral and physiological parameters) or unidimensional (relying only on behavioral indicators)[6].

A rare congenital condition, tracheoesophageal fistula (TOF), with or without esophageal atresia (EA), is thought to affect 1 in 3,000 to 4,000 live births worldwide[7]. Although TOF can happen on its own, almost 50% of neonates who are affected have other congenital abnormalities. After thoracotomy for TOF repair, the postoperative pain is one of the worst that is seen in neonatal surgery, especially in the first twenty-four hours. Inadequate analgesia after thoracotomy can cause severe cardiorespiratory instability and put newborns at risk for chronic pain sensitivity[7].

Since its initial introduction by Forero in 2016 as a treatment for thoracic neuropathic pain, the erector spinae plane block (ESPB) has become well-liked for a variety of surgical indications in patients of all ages. Numerous thoracic levels have seen its successful application for procedures such as upper abdominal interventions (T7–T8), thoracic and breast operations (T4–T5), and shoulder surgery (T2)[8].

In this procedure, a local anesthetic is deposited between the erector spinae muscle and the transverse process of the thoracic vertebra under the guidance of ultrasound imaging (Figure 1). This enables the anesthetic to produce effective analgesia over a wide area by spreading medially and longitudinally into the paravertebral space[9,10].

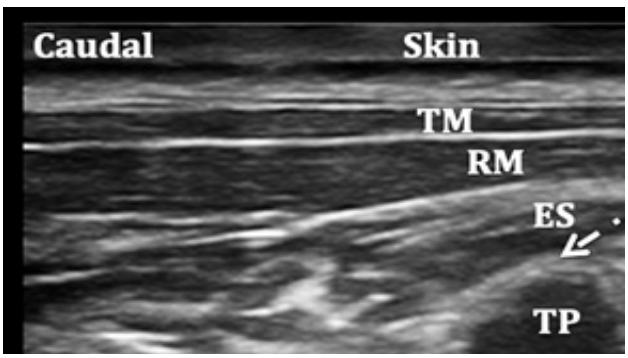

Fig. 1: Ultrasound guided erector spinae plane block (ESPB); TM: Trapezius muscle; RM: Rhomboid muscle; ES: Erector spinae; TP: Transverse process.

By using different adjuvants, the effectiveness of regional anesthesia in pediatric patients has been improved[11]. During pediatric surgeries, dexmedetomidine, a selective α2-adrenergic receptor agonist, has been shown to extend analgesia when used in caudal blocks with local anesthetics[12]. Additionally, research indicates that in experimental models, perineural dexmedetomidine added to bupivacaine prolongs sensory and motor block durations without causing neurotoxic side effects[13]. Furthermore, in pediatric populations, dexmedetomidine has been demonstrated to prolong the analgesic effects of peripheral nerve blocks[14,15].

In the present study, neonates undergoing thoracotomy for TOF repair were examined to determine the effects of bupivacaine plus dexmedetomidine in ultrasound-guided ESPB as opposed to bupivacaine alone. Postoperative pain and stress response are the main outcomes evaluated, and the length of hospital stay (LOS), the requirement for extra analgesics, and the frequency of respiratory complications in each group are the secondary outcomes.

PATIENTS AND METHODS

After being approved by the Institutional Medical Ethics Committee, this prospective study, which involved 90 neonates scheduled for tracheoesophageal fistula (TOF) repair, was carried out at El-Shatby Paediatric Hospital.

Sample size was calculated using Power Analysis and Sample Size Software (PASS 2020) "NCSS, LLC. Kaysville, Utah, USA, ncss.com/software/pass". Based on Alimian *et al.,* (2021), they reported a Cohen's d≈−1.46 (i.e. a very large effect) for key postoperative outcomes such as opioid use and pain scores when adding dexmedetomidine to bupivacaine versus bupivacaine alone. The minimal total hypothesized sample size of 90 eligible neonates undergoing tracheoesophageal fistula repair (45 per group) is needed to evaluate the efficacy and safety of adding dexmedetomidine to bupivacaine in ultrasound-guided erector spinae plane block for neonates undergoing tracheoesophageal fistula repair, with assessment of postoperative pain (using NIPS), salivary cortisol levels, postoperative complications, and NICU stay; taking into consideration an assumed effect size (Minimally Clinically Important Difference) of 20%, 95% level of confidence, compliance ratio (1:1), and power of 90% using Chi square- test. The sample size is accepted to be adequate by the department of Statistics, Medical Research Institute, Alexandria University, Egypt[16].

The neonates who were enrolled ranged in age from 0 to 30 days. Neonates with any contraindication to regional anesthesia, congenital heart disease, prematurity,

birth weight <2.4kg, vertebral abnormalities, or those in need of mechanical ventilation were excluded.

Each newborn was evaluated clinically and physically upon admission, and baseline laboratory tests, such as coagulation profile, liver and renal function tests, and complete blood count (CBC), were performed. A chest *X*-Ray, arterial blood gas analysis (including pH, bicarbonate (HCO_3^-), PaO_2, $PaCO_2$, base excess (BE), and lactate levels), and serum electrolyte levels (sodium and potassium) comprised the radiological and biochemical evaluations.

Forty-five minutes before the induction of anesthesia, atropine was administered intramuscularly at a dose of 0.02mg/kg as part of the premedication process. A multi-channel monitor (Trakmon, Kontron Ltd, UK) was used to set up intraoperative monitoring for arterial oxygen saturation (SaO_2), end-tidal carbon dioxide ($ETCO_2$), non-invasive arterial blood pressure, and continuous electrocardiography (ECG). Sevoflurane was inhaled in oxygen at a flow rate of 3L/min to induce anesthesia. After induction, Ringer's lactate solution was given at a rate of 8–10mL/kg via a 24-gauge peripheral intravenous cannula. During the intubation procedure, a lubricated nasopharyngeal airway of the proper size was positioned to sustain spontaneous respiration using sevoflurane.

A flexible 2.2mm fiberoptic bronchoscope was used to facilitate oral intubation by passing it through an Air-Q Intubating Laryngeal Mask Airway (ILMA). Sevoflurane (1–2%) was used to maintain anesthesia in a 50:50 oxygen and air mixture. A positive end-expiratory pressure (PEEP) of 3cmH_2O, a trigger sensitivity of 0.7 and a pressure support mode with pressures between 12 and 15cmH_2O were among the ventilation parameters.

With the neonate in the left lateral decubitus position, the ultrasound-guided erector spinae plane block (ESPB) was carried out. By counting down from the seventh cervical vertebra (C7), the fifth thoracic vertebra (T5) was located following aseptic preparation. Using a high-frequency linear ultrasound probe (Sonosite M Turbo, FUJIFILM, Bothell, WA, USA), the transverse process was located by positioning it at the T5 level and moving it laterally. After that, the probe was turned to a sagittal view so that the erector spinae muscle beneath the trapezius could be seen. A 22-gauge, 80mm Stimuplex D needle (B. Braun, Germany) was advanced toward the transverse process after being inserted in-plane. Once the needle's position beneath the erector spinae muscle's anterior fascia has been confirmed by hydro dissection with 0.5mL of saline, the local anesthetic was administered.

Randomization and Blindness:

Two groups of forty-five neonates each were formed by random assignment of the patients using a random number generator (Research Randomizer Version 4.0). Group 1 was provided with ESPB with 0.5mL/kg of 0.25% bupivacaine and 0.5μg/kg of dexmedetomidine[17]. In Group 2, ESPB was administered at the same volume with 0.25% bupivacaine but without dexmedetomidine. Every eight hours after surgery, all patients received intravenous paracetamol at a dose of 10mg/kg. The drug solutions were prepared by an independent anesthesiologist not involved in patient care or data collection. The anesthesiologist performing the block, the surgical and nursing teams, and the outcome assessors were all blinded to the study drugs.

In cases where the Neonatal Infant Pain Scale (NIPS) score was higher than 4, rescue analgesia was given via intravenous fentanyl at a dose of 1μg/kg. At various intervals, including pre-induction, post-induction, at the time of skin incision, every 15 minutes during the procedure, and at 2, 6, 12 and 24 hours after the procedure, hemodynamic parameters were recorded. At six and twenty-four hours after surgery, arterial blood gas analysis was performed again. The NIPS score was used to measure pain every 30 minutes for the first two hours, and then every two hours for the following twenty-four hours (Figure 2).

	Score	Finding	Details
Facial expression	0	Relaxed muscle	Restful face, neutral expression
	1	Grimace	Tight facial muscles, furrowed brow, chin, jaw
Cry	0	No cry	Quiet, not crying
	1	Whimper	Mild moaning, intermittent
	2	Vigorous cry	Loud scream, rising, shrill, continuous
Breathing patterns	0	Relaxed	Usual pattern for this baby
	1	Changed	Indrawing, irregular, faster, gagging
Arms	0	Relaxed/restrained	No muscular rigidity, occasional movement
	1	Flexed/extended	Tense, straight arms, rigid, extension/flexion
Legs	0	Relaxed/restrained	No muscular rigidity, occasional movement
	1	Flexed/extended	Tense, straight legs, rigid, extension/flexion
State of arousal	0	Sleeping/awake	Quiet, peaceful, sleeping, or alert and settled
	1	Fussy	Alert, restless, and thrashing

Fig. 2: Neonatal Infant Pain Scale (NIPS).

Preoperative and postoperative measurements of salivary cortisol levels were made in order to assess the stress response. Saliva was typically collected using salivates, gently placed in the buccal cavity to absorb an adequate volume of saliva. To minimize confounding variables, feeding and oral manipulations was avoided for at least 30 minutes prior to collection. Following collection, samples were stored at 4˚C if analyzed within a few hours, or frozen at –20˚C to –80˚C for longer preservation. Cortisol concentrations were measured using enzyme-linked immunosorbent assay (ELISA). The Salivary Cortisol ELISA kit is based on the idea of competition and microplate separation. The binding sites of mouse

monoclonal Cortisol -antiserum coated onto the wells are competed for by an undetermined amount of Cortisol in the sample and a fixed amount of Cortisol coupled with horseradish peroxidase. The microplate is rinsed after one hour of incubation to terminate the competition response. The concentration of Cortisol after the addition of the substrate solution is inversely related to the optical density measure[18,19].

Morning salivary sample collection was withdrawn from 7 to 8am preoperatively and 24 hours later[20].

Alongside the assessment of pain, the Downes scoring system was used to determine the prevalence of respiratory distress. The length of the NICU stay, postoperative complications, time to first opioid administration, and total opioid consumption were also recorded.

Statistical analysis:

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp). Categorical data were represented as numbers and percentages. Chi-square test was applied to compare between two groups. Alternatively, for continuous data, they were tested for normality by the Shapiro-Wilk test. Quantitative data were expressed as range (minimum and maximum), mean, standard deviation and median Student *t*-test was used to compare two groups for normally distributed quantitative variables. On the other hand, Mann Whitney test was used to compare two groups for not normally distributed quantitative variables. Significance of the obtained results was judged at the 5% level.

RESULTS

Ninety-seven neonates in all were evaluated for eligibility. Seven of these were disqualified from participating, three because the parents refused to take part and four because of intraoperative surgical complications. The remaining 90 neonates were enrolled in the study after meeting the inclusion criteria [Flowchart 1]. Both groups' data distribution was verified to be normal (Figure 3).

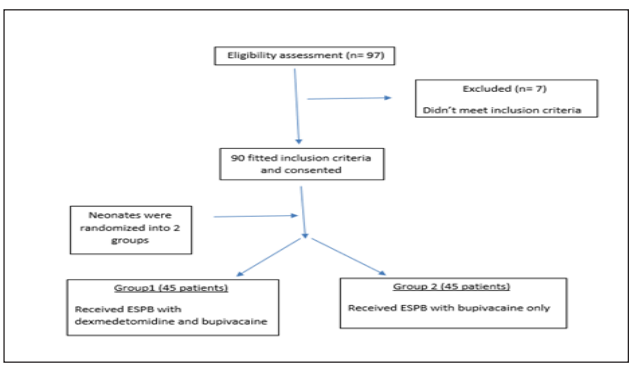

Fig. 3: Flow chart of patients.

Age, sex and body weight were among the demographic characteristics that did not differ statistically significantly between the two groups.

Hemodynamic and Arterial blood gas measures (Table 1-3):

Heart rate, mean arterial blood pressure, and mean oxygen saturation—all hemodynamic measures—were also similar between the groups during the intraoperative and postoperative observation periods. There were no noticeable variations between the groups when arterial blood gas values were analyzed before induction, six hours and twenty-four hours after surgery.

Postoperative Pain Assessment (NIPS Scale) (Table 4 and Figure 4):

At the immediate postoperative time points (0, 30, 60, 90 and 120 minutes) and at 4, 6, 8 and 10 hours, Group 1's Neonatal Infant Pain Scale (NIPS) scores were lower than Group 2's; however, these differences were not statistically significant. Notably, Group 1 showed significantly lower pain scores than Group 2 from 12 to 24 hours postoperatively (at 2-hour intervals) (p<0.001).

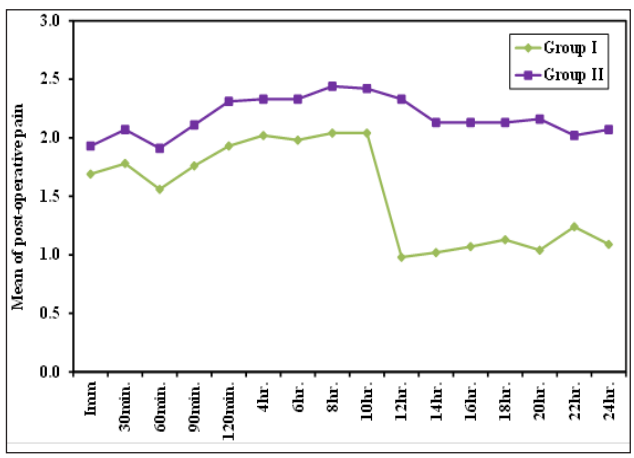

Fig. 4: Comparison between the two studied groups according to post-operative pain.

Salivary Cortisol Levels (Table 5 and Figure 5):

Both groups experienced an increase in postoperative salivary cortisol levels. The mean cortisol level in Group 1 was 30.63±21.95mmol/L before surgery, and it increased to 55.73±36.18mmol/L 24 hours after surgery. With preoperative levels of 36.58±25.60mmol/L and postoperative levels of 64.48±32.39mmol/L, Group 2 showed a similar pattern. Intergroup comparisons showed no statistically significant differences either before surgery (p= 0.589) or 24 hours after surgery (p= 0.164), despite the fact that both groups showed an increase in cortisol. The delta change in cortisol level before and after surgery (Δ) was higher in group 2 than group 1.

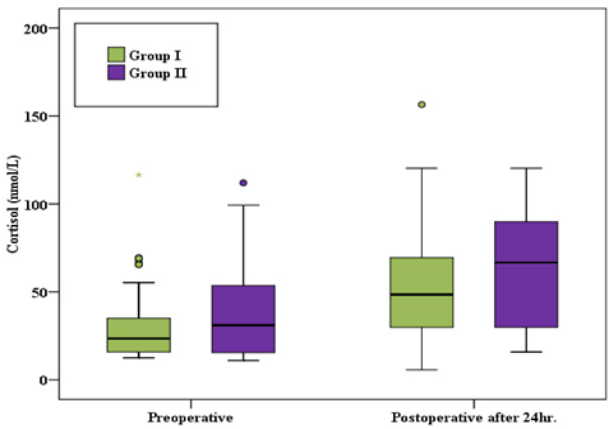

Fig. 5: Comparison between the two studied groups according to salivary cortisol level (mmol/L).

Respiratory Assessment – Downes Score (Table 6):

At standardized postoperative intervals (immediately after extubation, then at 30, 60, 90 and 120 minutes, followed by 2-hour intervals up to 24 hours), the Downes score was used to track respiratory status. At every time point evaluated, there were no discernible differences between the two groups.

Analgesic Duration and Opioid Consumption (Table 7 and Figure 6):

Group 1 experienced a longer mean duration prior to administering rescue opioid analgesia (17±5.29 hours) than Group 2 (9.27±7.17 hours); however, the difference was close to but fell short of statistical significance (p= 0.078). Nonetheless, Group 1's overall opioid intake was significantly lower (2.88±0.25μg) than Group 2's (7.64±4.78μg) (p= 0.040). Furthermore, compared to 11 neonates in Group 2, only 4 neonates in Group 1 needed rescue opioid administration.

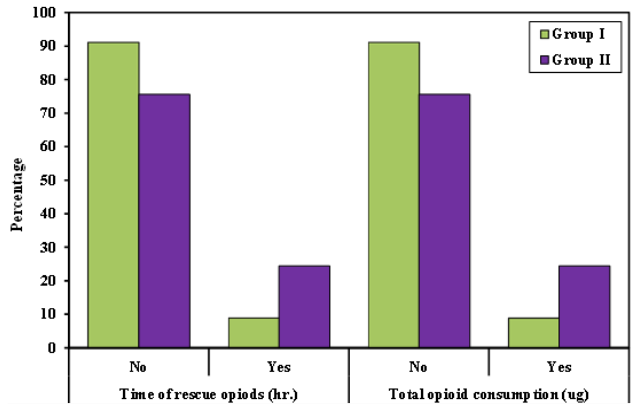

Fig. 6: Comparison between the two studied groups according to time of rescue opioids and total opioid consumption.

Length of NICU Stay (Table 8):

Group 1 experienced a significantly shorter average length of stay in the NICU (3.00±0.71 days) compared to Group 2(3.87±0.81 days) (p<0.001), suggesting that adding dexmedetomidine had a positive effect on recovery time.

Table 1: Comparison between the two studied groups according to MABP and HR:

	MABP				HR			
	Group I (n= 45)	**Group II (n= 45)**	***t***	***p***	**Group I (n= 45)**	**Group II (n= 45)**	***t***	***p***
Pre induction	52.29±4.36	53.13±3.33	1.032	0.305	148.3±10.76	148.8±11.80	0.243	0.809
Post induction	41.62±2.62	42.78±3.13	1.900	0.061	130.4±9.28	128.2±9.97	1.073	0.286
At surgical assimilation	46.36±3.52	46.09±3.74	0.348	0.729	131.4±10.91	129.6±11.21	0.781	0.437
15min.	46.89±2.57	45.87±3.44	1.599	0.114	127.2±8.66	124.3±8.27	1.631	0.106
30min.	46.18±3.06	45.00±2.98	1.850	0.068	127.0±7.24	125.2±7.22	1.195	0.235
45min.	47.89±2.84	47.16±3.10	1.171	0.245	135.1±8.63	134.3±8.84	0.410	0.682
60min.	48.24±2.21	47.36±3.35	1.486	0.141	134.3±8.10	133.3±8.14	0.571	0.569
2hr.	48.76±1.98	48.71±2.90	0.085	0.933	146.9±10.56	145.8±11.80	0.480	0.632
6hr.	48.40±3.06	48.07±3.08	0.515	0.608	132.9±11.22	132.2±11.88	0.301	0.764
12hr.	48.18±3.64	47.60±3.51	0.766	0.446	133.9±11.43	132.9±11.92	0.433	0.666
24hr.	48.64±3.65	47.91±3.55	0.966	0.336	134.4±11.66	131.4±11.27	1.222	0.225

Data was expressed using Mean±SD; SD: Standard deviation; *t*: Student *t*-test; *p*: *p* value for comparing between the two studied groups.

Table 2 : Comparison between the two studied groups according to O_2%:

O_2%	Group I (*n*= 45)	Group II (*n*= 45)	*t*	*p*
Pre induction	94.16±1.64	94.09±1.58	0.197	0.845
Post induction	98.31±0.63	98.33±0.64	0.166	0.869
At surgical assimilation	98.56±0.50	98.53±0.50	0.209	0.835
15min.	94.82±1.70	94.51±2.10	0.774	0.441
30min.	86.40±1.76	86.20±1.80	0.532	0.596
45min.	86.82±1.59	86.60±1.57	0.668	0.506
60min.	97.38±1.43	97.47±1.42	0.295	0.769
2hr.	98.44±0.72	98.51±0.51	0.506	0.614
6hr.	98.38±0.49	98.49±0.51	1.058	0.293
12hr.	98.80±0.40	98.78±0.47	0.240	0.811
24hr.	99.07±0.39	99.09±0.36	0.280	0.780

Data was expressed using Mean±SD; SD: Standard deviation; *t*: Student *t*-test; *p*: *p* value for comparing between the two studied groups.

Table 3: Comparison between the two studied groups according to PH, HCO_3 and PCO_2:

	Group I (*n*= 45)	Group II (*n*= 45)	*t*	*p*
PH				
Pre induction	7.37±0.05	7.36±0.05	1.398	0.165
6hr.	7.36±0.05	7.41±0.46	0.655	0.514
24hr.	7.37±0.05	7.39±0.05	1.476	0.144
HCO_3				
Pre induction	23.40±1.27	23.91±1.36	1.842	0.069
6hr.	23.84±1.43	23.73±1.29	0.388	0.699
24hr.	23.04±1.07	22.64±1.13	1.727	0.088
PCO_2				
Pre induction	37.91±3.40	37.62±3.10	0.421	0.675
6hr.	38.29±3.60	37.22±2.55	1.621	0.109
24hr.	39.09±3.87	39.18±3.21	0.118	0.906

Data was expressed using Mean±SD; SD: Standard deviation; *t:* Student *t*-test; *p*: *p* value for comparing between the two studied groups.

Table 4: Comparison between the two studied groups according to post-operative pain:

Post-operative pain	Group I (*n*= 45)	Group II (*n*= 45)	*U*	*p*
Imm				
Mean±SD.	1.69±0.73	1.93±1.05	858.50	0.185
Median (Min. – Max.)	2(0–4)	2(0–4)		
30min.				
Mean±SD.	1.78±0.74	2.07±0.99	814.00	0.083
Median (Min. – Max.)	2(0–4)	2(0–4)		
60min.				
Mean±SD.	1.56±0.69	1.91±1.12	835.50	0.131
Median (Min. – Max.)	2(0–3)	2(0–4)		
90min.				
Mean±SD.	1.76±0.88	2.11±1.15	826.00	0.116
Median (Min. – Max.)	2(0–4)	2(0–4)		
120min.				
Mean±SD.	1.93±0.86	2.31±1.18	801.50	0.076

Post-operative pain	Group I (*n*= 45)	Group II (*n*= 45)	*U*	*p*
Median (Min. – Max.)	2(1–4)	2(0–5)		
4hr.				
Mean±SD.	2.02±0.97	2.33±1.15	854.50	0.184
Median (Min. – Max.)	2(0–4)	2(0–5)		
6hr.				
Mean±SD.	1.98±0.87	2.33±1.19	865.50	0.214
Median (Min. – Max.)	2(0–4)	2(0–5)		
8hr.				
Mean±SD.	2.04±1.11	2.44±1.24	822.50	0.112
Median (Min. – Max.)	2(0–5)	2(0–5)		
10hr.				
Mean±SD.	2.04±1.15	2.42±1.22	842.00	0.155
Median (Min. – Max.)	2(0–5)	2(0–5)		
12hr.				
Mean±SD.	0.98±0.72	2.33±1.02	297.50*	<0.001*
Median (Min. – Max.)	1(0–2)	2(0–5)		
14hr.				
Mean±SD.	1.02±0.92	2.13±0.89	353.00*	<0.001*
Median (Min. – Max.)	1(0–5)	2(1–5)		
16hr.				
Mean±SD.	1.07±0.75	2.13±0.99	404.50*	<0.001*
Median (Min. – Max.)	1(0–3)	2(0–5)		
18hr.				
Mean±SD.	1.13±0.81	2.13±1.10	426.00*	<0.001*
Median (Min. – Max.)	1(0–5)	2(0–5)		
20hr.				
Mean±SD.	1.04±1	2.16±1.11	451.00*	<0.001*
Median (Min. – Max.)	1(0–5)	2(0–5)		
22hr.				
Mean±SD.	1.24±1	2.02±1.01	574.50*	<0.001*
Median (Min. – Max.)	1(0–4)	2(0–5)		
24hr.				
Mean±SD.	1.09±0.85	2.07±0.94	469.50*	<0.001*
Median (Min. – Max.)	1(0–3)	2(0–5)		

SD: Standard deviation; *U*: Mann Whitney test; *p*: *p* value for comparing between the two studied groups.

Table 5: Comparison between the two studied groups according to salivary cortisol level (mmol/L):

Cortisol (mmol/L)	Group I (*n*= 45)	Group II (*n*= 45)	*U*	p
Preoperative				
Mean±SD.	30.63±21.95	36.58±25.60	945.50	0.589
Median (Min. – Max.)	23.50(12.50–116.50)	31(11–112)		
Postoperative after 24hr.				
Mean±SD.	55.73±36.18	64.48±32.39	840.00	0.164
Median (Min. – Max.)	48.50(5.65–156.50)	66.70(15.80–120.30)		

SD: Standard deviation; *U*: Mann Whitney test; *p*: *p* value for comparing between the two studied groups.

Table 6: Comparison between the two studied groups according to Downes:

Downes score	Group I (*n*= 45)	Group II (*n*= 45)	*U*	*p*
Imm				
Mean±SD.	3.47±0.63	3.69±1.02	825.00	0.096
Median (Min. – Max.)	4(2–4)	4(1–6)		
30min.				
Mean±SD.	2.64±1.09	2.98±1.29	850.50	0.175
Median (Min. – Max.)	2(0–4)	3(0–5)		
60min.				
Mean±SD.	2.51±1.14	2.91±1.18	817.00	0.103
Median (Min. – Max.)	2(0–4)	3(0–5)		
90min.				
Mean±SD.	2.31±1.14	2.76±1.25	796.00	0.071
Median (Min. – Max.)	2(1–4)	3(0–5)		
120min.				
Mean±SD.	2.07±1.01	2.36±0.93	798.00	0.064
Median (Min. – Max.)	2(1–4)	2(0–4)		
4hr.				
Mean±SD.	2.07±1.03	2.38±1.03	809.00	0.080
Median (Min. – Max.)	2(1–4)	2(0–5)		
6hr.				
Mean±SD.	2.02±0.97	2.29±0.87	815.00	0.081
Median (Min. – Max.)	2(1–4)	2(0–4)		
8hr.				
Mean±SD.	2.11±0.98	2.40±1.07	862.00	0.189
Median (Min. – Max.)	2 (1 – 4)	2(0–5)		
10hr.				
Mean±SD.	1.89±1.27	2.31±1	806.50	0.072
Median (Min. – Max.)	2(0–4)	2(0–5)		
12hr.				
Mean±SD.	1.69±1.20	1.98±0.78	809.00	0.080
Median (Min. – Max.)	2(0–4)	2(0–5)		
14hr.				
Mean±SD.	1.58±1.03	1.89±0.65	825.50	0.102
Median (Min. – Max.)	2(0–4)	2(0–3)		
16hr.				
Mean±SD.	1.58±0.89	1.87±0.66	822.50	0.091
Median (Min. – Max.)	2(0–4)	2(1–4)		

Downes score	Group I (*n*= 45)	Group II (*n*= 45)	*U*	*p*
18hr.				
Mean±SD.	1.49±0.89	1.73±0.69	804.50	0.061
Median (Min. – Max.)	1(0–4)	2(0–4)		
20hr.				
Mean±SD.	1.44±1.01	1.62±0.53	803.00	0.064
Median (Min. – Max.)	1(0–4)	2(0–2)		
22hr.				
Mean±SD.	1.20±1.06	1.33±0.64	801.00	0.060
Median (Min. – Max.)	1(0–4)	1(0–2)		
24hr.				
Mean±SD.	1.33±0.95	1.49±0.63	805.50	0.064
Median (Min. – Max.)	1(0–4)	2(0–3)		

SD: Standard deviation; *U*: Mann Whitney test; *p*: *p* value for comparing between the two studied groups.

Table 7: Comparison between the two studied groups according to Time of rescue opioids and Total opioid consumption:

	Group I (*n*= 45)	Group II (*n*= 45)	Test of Sig.	*p*
Time of rescue opiods (hr.)				
No	41(91.1%)	34(75.6%)	χ^2= 3.920*	0.048*
Yes	4(8.9%)	11(24.4%)		
$Mean±SD.	1.51±5.08	2.27±5.28	*U*= 868.50	0.073
Median (Min. – Max.)	0(0–22)	0(0–22)		
Total opioid consumption (ug)	(*n*= 4)	(*n*= 11)		
No	41(91.1%)	34(75.6%)	χ^2= 3.920*	0.048*
Yes	4(8.9%)	11(24.4%)		
#Mean±SD.	2.88±0.25	7.64±4.78	*U*= 6.00*	0.040*
Median (Min. – Max.)	3(2.50–3)	6(3–16)		

SD: Standard deviation; *U*: Mann Whitney test; χ^2: Chi square test; *p: p* value for comparing between the two studied groups; *: Statistically significant at $p \leq 0.05$.

Table 8: Comparison between the two studied groups according to Length of NICU stay:

	Group I (*n*= 45)	Group II (*n*= 45)	*U*	*p*
Length of NICU stay				
Mean±SD.	3±0.71	3.87±0.81	481.50*	<0.001*
Median (Min. – Max.)	3(2–4)	4(3–6)		

SD: Standard deviation; *U:* Mann Whitney test; *p*: *p* value for comparing between the two studied groups; *: Statistically significant at $p \leq 0.05$.

DISCUSSION

About 92% of patients with esophageal atresia (EA) have tracheoesophageal fistula (TOF), a congenital anomaly marked by abnormal communication between the esophagus and trachea or a major bronchus[21]. Acute pain is one of the biggest postoperative problems after thoracotomy for TOF repair[22]. Due to worries about respiratory and cardiovascular depression linked to opioid administration, proper perioperative analgesia in neonates is frequently not managed to its full potential, despite its vital importance[23,24].

There were no statistically significant differences between the two groups in the current study's intraoperative and postoperative hemodynamic parameters, such as heart rate, mean arterial blood pressure, and oxygen saturation. These results align with those of Siam *et al.,* who found that patients undergoing lumbar spine surgery who received erector spinae plane block (ESPB) in addition to general anesthesia had better hemodynamic stability than those who received traditional general anesthesia and multimodal analgesia[25].

To measure postoperative pain, the Neonatal Infant Pain Scale (NIPS) was used. Although Group 1 (bupivacaine + dexmedetomidine) experienced consistently lower pain scores than Group 2 (bupivacaine alone) during the first postoperative period, statistically significant decreases were noted between 12 and 24 hours after surgery. This analgesic superiority is probably due to dexmedetomidine's adjuvant effect. A recent meta-analysis has provided support for these findings by showing that α2-adrenergic agonists used as adjuncts to local anesthetics significantly extend the duration of pediatric peripheral nerve blocks[26].

After major abdominal surgery, Niraj and Tariq reported that continuous ESPB provided effective somatic and partial visceral analgesia, which led to a decrease in morphine consumption and consistently low Numeric Rating Scale (NRS) scores over a 48-hour period[27]. Chin et al. also reported reduced opioid requirements and lower NRS scores with single-level ESPB in patients undergoing laparoscopic ventral hernia repair[28].

On the other hand, in a retrospective study of 182 patients undergoing various open and laparoscopic surgeries, Tulgar *et al.,* found a 6.5% failure rate (12 patients), with no consistent contributing factors identified, including surgical type, anesthetic volume or concentration, or block level[29].

Salivary assays provide a non-invasive, accurate way to measure cortisol secretion, which can increase up to twentyfold in response to stress, particularly in neonates[30-32]. Using immunoradiometric techniques, earlier research has shown a positive correlation between serum and salivary cortisol in neonates[33,34]. There were no discernible differences between the groups at baseline or 24 hours after surgery, despite the fact that both groups in the current study showed postoperative increases in salivary cortisol.

These results are consistent with research by Tuncer *et al.,* that assessed prolactin, insulin, glucose, and cortisol levels in children undergoing genitourinary or abdominal surgery while under general anesthesia, with or without caudal epidural analgesia. The control group's plasma cortisol levels were considerably higher than those of the caudal group[35]. Likewise, Salerno et al. showed that the cortisol response to surgery was decreased in infants younger than one year old when they were under regional (epidural) anesthesia[36].

The duration of NICU stay and opioid use are additional postoperative factors to consider after neonatal thoracotomy. Compared to Group 2, Group 1 in this study showed a significantly lower total opioid requirement and a longer time before the first dose of rescue analgesia. Compared to eleven neonates in Group 2, only four in Group 1 needed additional fentanyl. Additionally, Group 1's NICU stay was much shorter (2–4 days) than Group 2's (3–6 days), indicating that the addition of dexmedetomidine improved postoperative recovery.

After thoracotomy, there is a known risk of respiratory complications. The Downes score is a clinical tool used to detect respiratory distress in neonates. While a score of >7 denotes imminent respiratory failure, a score of >4 indicates moderate distress. The groups in our study did not significantly differ in their Downes scores during the first 24 hours following surgery. Two patients in Group 1 and one in Group 2 had transient bradycardia (less than 100 beats per minute), which was successfully treated with atropine and left no after effects.

Numerous factors, such as complications, analgesic techniques, nutritional status, and pulmonary outcomes, were assessed in a retrospective analysis conducted by Türkylmaz *et al.,* on 103 pediatric patients (ages 1 month to 18 years) undergoing thoracotomy. According to the study's findings, the risk of pulmonary complications is considerably decreased by receiving proper postoperative analgesia[37]. Ineffective pain management after thoracotomy has been linked to pulmonary compliance impairment, decreased effective coughing, and secretion retention, all of which increase the risk of pneumonia and atelectasis[38,39].

Because this study was only carried out at one location, its generalizability may be limited. Results may also be impacted by variations in surgical technique brought on by different surgeons performing the same procedures. Furthermore, the 24-hour postoperative follow-up period may not have been enough to adequately document long-term analgesic efficacy and complications.

CONCLUSIONS

According to the study's findings, adding dexmedetomidine as a supplement to local anesthetics significantly improved postoperative analgesia, extended the duration of pain relief, and reduced the need for additional analgesics—all without causing any notable side effects. Consequently, dexmedetomidine showed a good safety record and effectiveness when used as a pediatric regional anesthesia adjunct.

ABBREVIATIONS

TOF: Tracheo-osophageal fistula; **LOS:** Length of stay; **ESPB:** Erector spinae plane block; **NICU:** Neonatal intensive care unit; **OA:** Esophageal atresia; **USG:** Ultrasound-guided approach; **LA:** Local anesthetic; **ABG:** Arterial blood gases; **$ETCO_2$:** End-Tidal carbon dioxide

tension; **ILMA:** Intubating laryngeal mask airway; **NIPS:** Neonatal Infant Pain Scale; **NRS:** Normal rating score.

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CONFLICT OF INTERESTS

There are no conflicts of interest.

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