ORIGINAL ARTICLE

Success rates and complications of awake caudal versus spinal block in preterm infants undergoing inguinal hernia repair: A prospective study

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ABSTRACT

Background: Inguinal hernia is a common disease in preterm infants necessitating surgical repair. Despite the increased risk of postoperative apnea in preterm infants, the procedure was conventionally performed under general anesthesia. Recently, regional anesthesia approaches, including spinal and caudal blocks have been proposed as safe and efficient alternative anesthesia methods in this group of patients. The current study evaluates awake caudal and spinal blocks in preterm infants undergoing inguinal hernia repair. **Materials and Methods:** In a randomized clinical trial, 66 neonates and infants (weight <5 kg) undergoing inguinal hernia repair were recruited in Tabriz Teaching Children Hospital during a 12-month period. They were randomly divided into two equal groups; receiving either caudal block by 1 ml/kg of 0.25% bupivacaine plus 20 μg adrenaline (group C) or spinal block by 1 mg/kg of 0.5% bupivacaine plus 20 μg adrenaline (group S). Vital signs and pain scores were documented during operation and thereafter up to 24 h after operation. **Results:** Decrease in heart rate and systolic blood pressure was significantly higher in group C throughout the study period ($P < 0.05$). The mean recovery time was significantly higher in group S (27.3 ± 5.5 min vs. 21.8 ± 9.3 min; $P = 0.03$). Postoperative need for analgesia was significantly more frequent in group S (75.8% vs. 36.4%; $P = 0.001$). Failure in anesthesia was significantly higher in group S (24.4% vs. 6.1%; $P = 0.04$). **Conclusion:** More appropriate success rate, duration of recovery and postoperative need of analgesics could contribute to caudal block being a superior anesthesia technique compared to spinal anesthesia in awaked preterm infants undergoing inguinal hernia repair.

Key words: *Anesthesia, caudal, inguinal hernia, preterm infants, spinal*

INTRODUCTION

Inguinal hernias occur quite frequently in preterm infants[1] and considering the risk of incarcerated hernia and intestinal obstruction; they should be repaired under general anesthesia (GA) shortly after patients becoming medically stable.[2,3] GA predisposes preterm infants to the high risk of postoperative apnea. Spinal anesthesia is used in some institutions on infants undergoing infra-umbilical surgeries.[4] Postoperative apnea in preterm infants having received spinal anesthesia has been reported in some studies,[5] whereas others are not reporting this complication.[4-6] To reduce postoperative apnea, other centers use caudal anesthesia in each preterm infant as an alternative method to GA and narcotics.[7,8] An efficient and safe method introduced in 1990, caudal epidural block with bupivacaine provides appropriate analgesia intra- and post-operatively in lower abdominal surgeries.[9] In this study, we compared complication and success rates of caudal block and spinal anesthesia in awaked preterm infants undergoing inguinal hernia repair.

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Quick Response Code:	Website: www.saudija.org
	DOI: 10.4103/1658-354X.154704

MATERIALS AND METHODS

The current study is a double-blind randomized controlled clinical trial conducted in Tabriz Teaching Children Hospital during a 12-month period (January 21, 2010 through January 21, 2011). The study was registered by the number RCT201102014041N4. Sixty-six neonates and infants aged 0-2 months who were scheduled for inguinal hernia repair were allocated into two groups randomly using a Ranlist 1.2 for random numbers; group S (spinal anesthesia) and group C (caudal anesthesia). The mean gestational age of the subjects was 35 ± 3.2 weeks, and all subjects had postconceptual age of <60 weeks, birth weight of 1800-2500 g and weight at surgery of <5 kg. Two subjects had a history of apnea; however, no case of postoperative apnea was observed. Subjects with associated anomalies were excluded from the study during the preoperative visit. There were no technical complications. The patients and anesthesiologist who recorded vital signs, pain scores and complications were blind to the groups. Bradycardia was defined as heart rate (HR) <100/min and desaturation was defined as SpO_2 <90% apnea was defined as a respiratory pause with bradycardia. Taking alpha 0.05 and power of 80% and the probability of block failure in %5 of cases as the primary outcome and 15% difference in its incidence between two groups, using software power and sample size 3.0.43, 58 samples were estimated. To increase the validity of the study and the possible loss of samples 66 subjects were enrolled, 33 samples were placed randomly in each group. After Local Ethical Committee approval and obtaining informed parental consents, we explained these two forms of regional anesthesia and their complications to the parents throughout the preoperative visits. Children with no contraindication of spinal or caudal anesthesia were included. Subjects' diet was unrestricted until 4 h preoperatively. Intravenous (IV) dextrose 5% was infused 4 h prior to the operation as the maintenance serum. 0.5-1 ml of eutectic mixture of local anesthetic cream was applied to the probable needle insertion area; that is, over L4-S3 spaces 90 min prior to the surgery and later the area was covered with dressing. All subjects were given IV midazolam (0.03 mg/kg) before performing block. Operative room temperature was kept between 27°C and 30°C. Electrocardiogram, precordial stethoscope, noninvasive blood pressure monitoring and pulse oximetry were used for monitoring the patients. In group C, infants were placed in left lateral position with flexion of the hip.[10] A 22-gauge caudal needle was selected to perform the block. After negative aspiration test, 1 ml/kg of 0.25% bupivacaine, with 20 μg adrenaline 1:1000 was injected in caudal space, and then the infant was turned into a supine position. Lack of sensation to the external stimulus (pinching) at the anticipated levels after 15 min was defined as successful caudal anesthesia.

In group S, after the infant was seated on the operative table, his/her head was retained in neuter position. A 2.5 cm, 25-gauge Quincke spinal needle was inserted into L5-S1 interspace. Following subarachnoid placement, the local anesthetic solution (1 mg/kg of 0.5% hyperbaric bupivacaine, with 20 μg adrenaline 1:1000) was injected. Lack of sensation to the external stimulus at the anticipated levels as well as lower limbs paralysis after 2 min was defined as successful spinal anesthesia. In failed blocks, the preferred choice was GA with inhalational induction using sevoflurane and laryngeal mask airway (no1) insertion. Maintenance was achieved using N_2O, O_2 and sevoflurane. DW 2.5% in ringer lactate solution (10 ml/kg/h) was considered as the maintenance fluid during the surgery.

In all patients, we recorded vital signs (systolic and diastolic blood pressure [SBP and DBP], HR and SpO_2) before induction, after 10, 20, and 30 min of block, at the end of surgery, at the beginning of the recovery, 10 and 20 min of the recovery phase, and at the end of the recovery. Recovery time was considered when the motor block faded away (30-60 min); in addition, the time for the removal of the sensory block was set to the time that the pain of the patients started requiring administration of acetaminophen. We also recorded presence of apnea and need for analgesia at the postoperation period. Neonatal infant pain scale [Figure 1] was used to assess pain score; it consists of six criteria including facial expression, cry, breathing pattern, arms and legs positions, and state of arousal. Each behavioral indicator is scored with 0 or 1 except "cry," which has three possible descriptors therefore, being scored with a 0, 1 or 2. Total pain scores range from 0 to 7. The suggested interventions based upon the score. Scores ≥4 severe pain that need pharmacologic intervention.

Continuous data were reported as mean ± standard deviation and analyzed using repeated measurement of ANOVA. Categorical data were reported as numbers and percentages and analyzed using χ^2 or Fisher exact test as appropriate. Nonparametric data (e.g., times) were reported as median and range and were analyzed using Mann-Whitney U-test. $P < 0.05$ was considered as statistically significant. All analyses were performed

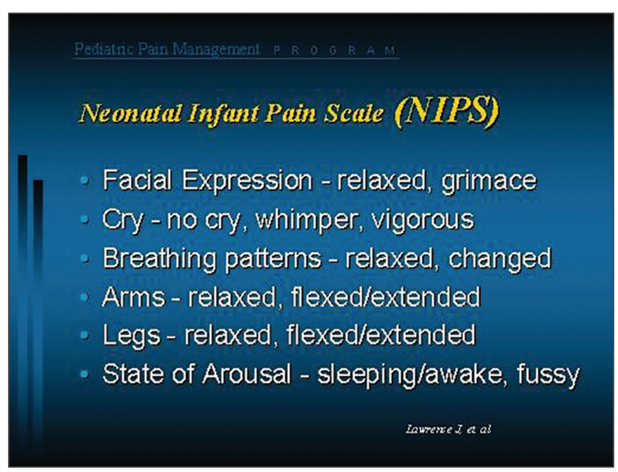

Figure 1: Neonatal infant pain scale

using SPSS software (version 15; SPSS, Inc., Chicago, IL, USA).

RESULTS

Sixty-six patients were studied, 33 in each group. Patient characteristics are presented in Table 1. There was no statistical significance between two groups regarding age, weight or sex. Mean SpO_2 and HR at different stages of operation in two groups are presented in Table 2. There was no statistical significance between two groups regarding SpO_2. No case of apnea was observed in any patient of each group. Mean HR was lower in group C, significantly at min 10 and 20 after block, beginning of recovery, min 10 and 20 after recovery, beginning of recovery and at the end of recovery. Mean SBP and DBP at different stages of operation in two groups are given in Table 3.

Table 1: Patient characteristics

Variable	Group C (*n* = 33)	Group S (*n* = 33)	*P*
Age (day)	39.7±13.3	43.0±12.5	0.35
Weight (g)	4037.9±965.3	4162.1±1108.4	0.63
Sex (male/female)	27/6	2 6/7	0.78

C: Caudal block; S: Spinal anesthesia; Data are presented as mean ± standard deviation; P: *P* value; *P* < 0.05 was considered significant

Mean SBP decreased significantly at all stages following block in two groups, being lower in group C. Mean DBP decreased in group C, significantly at min 20 after block, beginning of recovery, min10 after recovery and at the end of recovery. However, mean DBP increased at most stages after spinal anesthesia. On the other hand, no statistically significant difference was observed regarding DBP in two groups ($P = 0.09$). 20 min after block, only 1 patient had systolic pressure about 30 mmHg; we only administered 20 ml of IV fluid, after 5 min systolic pressure was 45 and 15 min later it was 65 mmHg. Mean recovery time was 27.3 ± 5.5 min in group S and 21.8 ± 9.3 min in group C ($P = 0.03$). Anesthetic or analgesic supplementation was not needed during surgery in any of patients in two groups; however, after being discharged from the recovery unit, 25 patients (75.8%) of group S and 12 patients (36.4%) of group C needed analgesic agents in the ward. Thus, need for analgesic agents after the recovery in group S was significantly more than group C ($P = 0.001$). In group S, 10 patients (40%) required analgesics (acetaminophen suppository) 1-2 h after operation, in 5 patients (20%) 3-4 h after operation, in 8 patients (32.5%) 4-5 h after operation and in 2 patients (8%) 6-8 h after operation. In group C, 2 patients (16.7%) required analgesics (acetaminophen suppository) 3-4 h after operation, in 7 patients (58.3%)

Table 2: Mean SpO_2 and HR at different stages of operation in two groups

Time	SPO_2(%)			HR (beat/min)		
	C (*n* = 33)	S (*n* = 33)	*P*	C (*n* = 33)	S (*n* = 33)	*P*
Baseline	99.4±1.1 (96-100)	99.4±1.2 (94-100)	0.1	159.8±16.8 (128-189)	164.1±18.7 (125-208)	0.33
10 min after block	98.9±1.6 (94-100)	99.8±1.5 (95-100)	0.86	133.2±15.6 (110-188)	146.7±19.5 (119-190)	0.003
20 min after block	98.8±1.2 (97-100)	99.0±1.2 (96-100)	0.61	128.1±16.0 (100-188)	136.1±13.0 (110-157)	0.03
30 min after block	99.2±1.0 (97-100)	99.0±2.0 (90-100)	0.70	128.7±12.4 (104-160)	135.0±16.8 (100-172)	0.10
End of surgery	99.1±1.0 (97-100)	99.3±0.8 (98-100)	0.30	129.3±18.3 (107-180)	133.2±16.7 (106-168)	0.39
Beginning of recovery	98.8±1.2 (96-100)	99.2±0.7 (98-100)	0.12	129.1±14.5 (107-160)	141.1±18.0 (112-180)	0.005
10 min after recovery beginning	99.1±1.2 (95-100)	99.1±0.9 (96-100)	0.77	130.0±11.4 (110-156)	139.5±13.6 (115-166)	0.005
20 min after recovery beginning	99.2±0.9 (97-100)	99.3± 0.8 (97-100)	0.63	130.1±11.0 (110-156)	140.2±14.2 (110-164)	0.003
End of recovery	99.6±0.6 (98-100)	99.4±0.9 (97-100)	0.37	131.0.±12.2 (113-160)	144.8±12.4 (118-165)	<0.001

C: Caudal block; S: Spinal anesthesia; *P*: *P* value; *P* < 0.05 was considered significant; Data are mean ± standard deviation (range)

Table 3. Mean systolic and diastolic blood pressure in different period of operation in two groups

Time	SBP (mmHg)			DBP (mmHg)		
	C (*n* = 33)	S (*n* = 33)	*P*	C (*n* = 33)	S (*n* = 33)	*P*
Baseline	80.7±11.0 (56-99)	80.7±17.2 (48-111)	0.99	41.0±10.3 (27-67)	38.9±13.7 (11-65)	0.49
10 minutes after block	73.8±7.1 (60-87)	79.9±12.4 (52-117)	0.02	36.7±6.1 (26-48)	40.8±11.0 (21-62)	0.08
20 minutes after block	68.3±11.3 (29-84)	79.9±11.5 (61-110)	<0.001	37.9±13.9 (22-84)	40.6±10.8 (23-70)	0.39
30 minutes after block	70.2±8.7 (47-86)	79.5±11.0 (59-110)	0.001	35.1±8.2 (23-56)	40.2±10.7 (26-70)	0.04
End of surgery	71.8±5.8 (62-83)	77.2±9.1 (56-94)	0.009	35.4±5.3 (24-44)	37.4±7.5 (25-54)	0.23
Beginning of recovery	72.3±8.3 (55-90)	81.9±8.3 (68-100)	<0.001	35.6±6.6 (22-50)	40.6±11.0 (30-89)	0.04
10 minutes after recovery beginning	72.7±8.9 (50-95)	79.7±10.1 (49-100)	0.006	34.8±5.8 (25-50)	38.2±4.8 (30-45)	0.02
20 minutes after recovery beginning	72.6±8.5 (50-91)	80.6±8.4 (65-100)	0.001	36.6±5.8 (25-50)	40.3±11.6 (30-94)	0.13
End of recovery	74.7±6.9 (62-90)	79.5±9.4 (51-100)	0.026	36.8±5.0 (30-50)	39.8±4.6 (30-51)	0.02

C: Caudal block; S: Spinal anesthesia; *P*: *P* value; *P* < 0.05 was considered significant; Data are mean ± standard deviation (range)

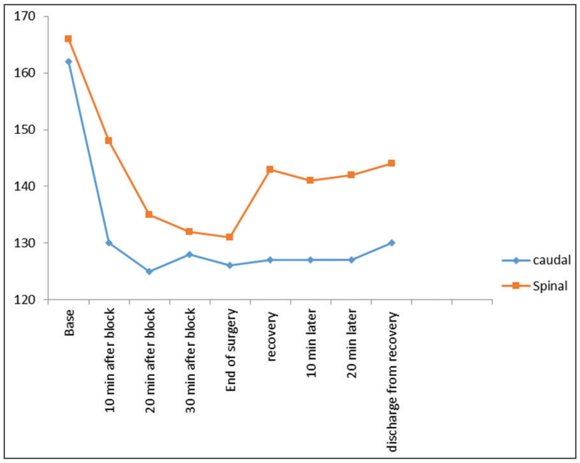

Figure 2: Heart rate changes

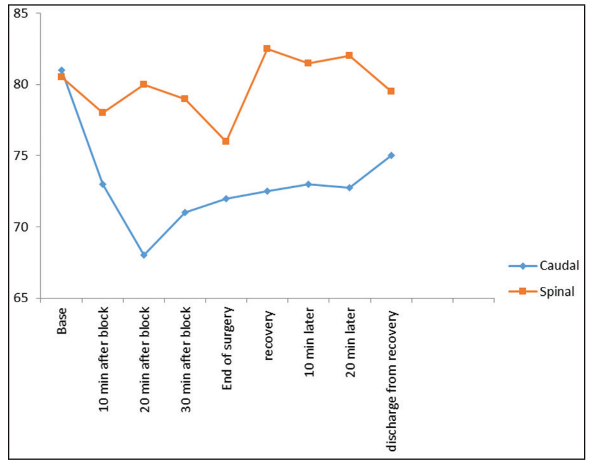

Figure 3: Systolic BP Changes in both groups

4-5 h after operation, and in 3 patients (25%) 6-8 h after operation. Failure rate was 6.1% (2 cases) and 24.2% (8 cases) in groups C and S, respectively; being significantly lower in group C ($P = 0.04$).

DISCUSSION

Our results showed that success rate of caudal block is higher than spinal anesthesia, as shown in previous studies.[4,11-16] Apnea incidence following spinal anesthesia in premature infants undergoing inguinal hernia repair varies from 0% to 11% in different reports. In contrast, the incidence after caudal block is nearly0%.[4,11] In our study, no case of apnea was observed in any cases of two groups. Similar to the study of Gerber[14] postoperative analgesia requirement after spinal anesthesia was more frequent and occurred earlier than caudal block, thus analgesic state provided by caudal block is more efficient than spinal anesthesia in premature infants undergoing inguinal hernia repair. More and earlier analgesic agents are required in the spinal group than caudal group postoperatively. Mean recovery time was longer in spinal than caudal group in our study. In contrast to the study of Bertrix *et al.*,[17] HR and SBP decreased after both caudal and spinal anesthesia techniques in our study [Figures 2 and 3]; however, the decrease in caudal group was more significant than spinal group; thus, hemodynamic stability after spinal anesthesia was better than caudal block in our study.

CONCLUSION

More appropriate success rate, duration of recovery and postoperative need of analgesics could contribute to caudal block being a superior anesthesia technique compared to spinal anesthesia in awaked preterm infants undergoing inguinal hernia repair.

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How to cite this article: Seyedhejazi M, Moghadam A, Sharabiani BA, Golzari SE, Taghizadieh N. Success rates and complications of awake caudal versus spinal block in preterm infants undergoing inguinal hernia repair: A prospective study. Saudi J Anaesth 2015;9:348-52.

Source of Support: Nil, **Conflict of Interest:** None declared.

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