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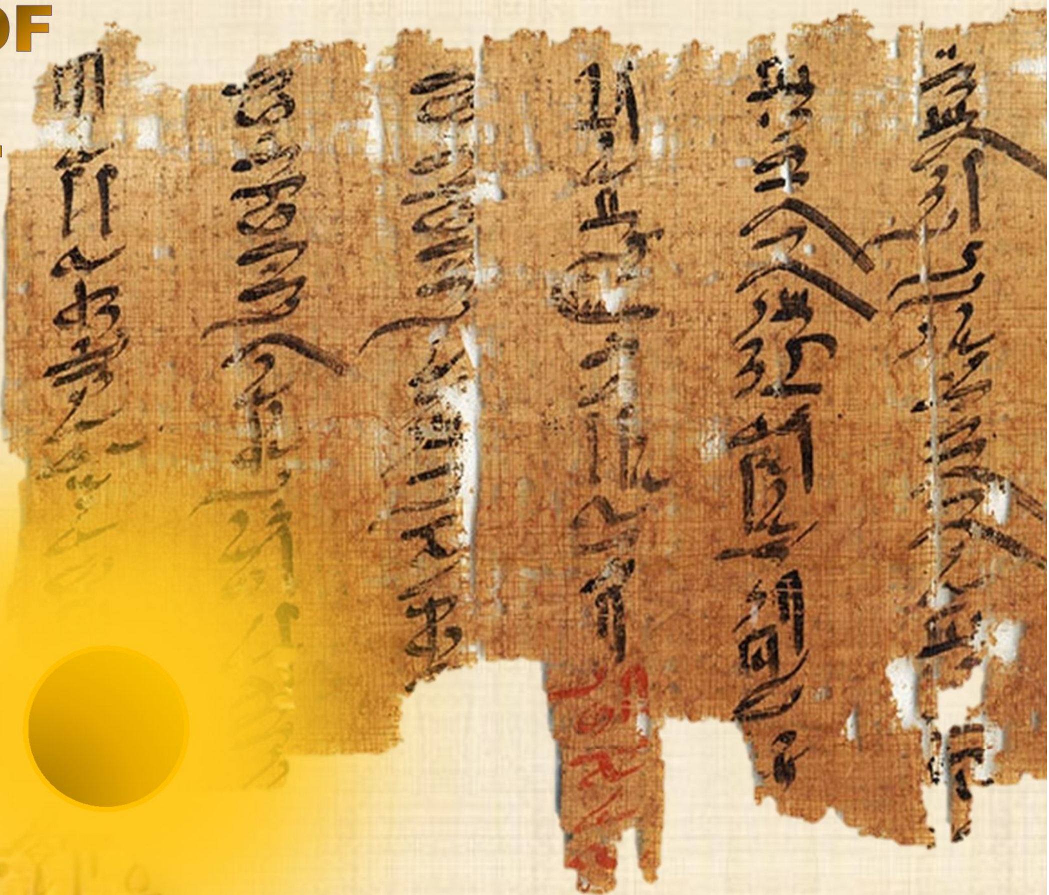

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Original article

# Spinal Versus Caudal Anesthesia in Lower Abdominal Surgeries in Pediatrics

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## ABSTRACT

**Background:** Regional anesthesia in pediatric surgery alone or combination with light general anesthesia provides several advantages, the most significant is intra- and post-operative pain relief.

**Aim of the work:** This study aimed to compare spinal to caudal anesthesia in children undergoing lower abdominal surgeries regarding [sensory and motor block as a primary outcome], hemodynamics and postoperative pain as a secondary outcome**.**

**Patients and Methods:** This study was a prospective randomized comparative clinical single-blind study. It included 40 children [ASA I or II] of both sexes, aged [3-9 years] undergoing lower abdominal surgeries. Patients were randomly assigned into one of two groups [20 patients in each group]. group [S] undergo spinal anesthesia, group [C] undergoes caudal anesthesia. To assess the following parameters; sensory and motor block, heart rate, mean arterial blood pressure and postoperative pain.

**Results:** Spinal anesthesia has a rapid onset of sensory block, more intensity than caudal anesthesia, but of shorter duration. Caudal anesthesia provides more time of motor block than spinal anesthesia. There was no statistically significant difference between groups regarding mean arterial pressure, but caudal anesthesia has more tachycardia than spinal anesthesia, and caudal anesthesia provides better postoperative analgesia more than spinal anesthesia.

**Conclusion:** Regional anesthesia in pediatrics is an effective and safe option. Caudal and spinal are both effective, however caudal have relatively more duration of postoperative analgesia and motor block than spinal anesthesia.

**Keywords:** Anesthesia; Caudal; Spinal; Pediatrics; Surgery.



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* Main subject and any subcategories have been classified according to the research topic.

## INTRODUCTION

Regional anesthesia may be suggested as an alternative to general anesthesia, particularly in situations such as chronic respiratory disorders, potentially difficult airway and malignant hyper-thermia[1]. Regional anesthesia, alone or combined with mild general anesthesia, has many advantages for pediatric patients. The most important benefit is intra-and postoperative relief of pain [2].

Some benefits include suppression of unwanted reflexes such as laryngospasm during circumcision and perianal procedures, early ambulation, early hospital discharge, decreased need for post-discharge non-narcotic analgesics, and a quicker return to the normally bright and alert state of the infant. Postoperative vomiting is less after regional anesthesia than when opiates are used for analgesia and earlier resumption of oral fluid intake is possible[3].

Spinal anesthesia produces full analgesia with deep relaxation of muscles, quiet respiration, and small contracted bowel [3].

Caudal anesthesia is a valuable complement to general anesthesia for pediatric lower abdominal surgeries as it offers intraoperative analgesia, a smooth healing time, and effective postoperative pain management, which decreases postoperative medication requirements[4].

The optimal analgesic and anesthetic approach for lower abdominal surgery among pediatrics have no consensus yet. It usually achieved by anesthetist preferences, and familiarity with approach. Thus, it is essential to obtain an objective rationale for optimal approach.

## AIM OF THE WORK

In this study we aimed to compare the efficacy of spinal and caudal anesthesia in children scheduled for lower abdominal surgeries, specifically for sensory and motor block [duration and intensity], hemodynamic changes, and postoperative pain.

## PATIENTS AND METHODS

This study was a prospective randomized comparative clinical single-blind study, from April to October 2019. After approval of the local and ethical committee of Al-Azhar university [Assiut], the present study had been conducted. It included 40 children [ASA I or II] of both sexes, aged [3-9 years] undergoing lower abdominal surgeries after taking an informed written consent from their parents or guardians.

Patients were randomly allocated by computer-generated numbers in sealed opaque envelopes into one of two groups [20 patients in each group]. group [S] for spinal anesthesia, and group [C] for caudal anesthesia. Every patient was subjected to a careful complete pre-anesthetic assessment, including preoperative history evaluation, physical examination and investigations [complete blood count [CBC] and coagulation studies], and adequate fasting period. In addition, the anesthetic technique had been explained to parents.

On arrival to the operating room, monitoring was done by applying electrocardiogram [ECG] leads, pediatric cuff for non-invasive determination of arterial blood pressure, and probe of pulse oximetry for heart rate and oxygen saturation. A peripheral venous cannula had been inserted; all patients were preloaded with a crystalloid solution [mix of normal saline 0.9% and pediament] 10 ml /kg, atropine [0.01 mg /kg] had been given as pre-anesthetic medication. All children had been sedated on the operating table using intravenous midazolam [0.05 mg/kg], then inhalation of sevoflurane 4% and oxygen via face mask, after achieving an adequate level of anesthesia, laryngeal mask airway of proper size was inserted according to patient's age, patients were left to breathe spontaneously throughout the operation.

**Spinal technique[5]:** After placement of the patient in left lateral decubitus with hips and knees flexed, the area was sterilized with povidone-iodine solution. The selected intervertebral space [L4-5] was punctured using spinal 25-gauge needle, after proper placement of spinal needle [obtaining free, pure cerebrospinal fluid [CSF]], hyperbaric bupivacaine [0.5%] was injected in subarachnoid space, in a dose [0.4 mg\kg], the injected volume was calculated by the equation: [ml = [age x 0.2 + weight x 0.5] ÷ 2].

**Caudal technique[6]:** After placement of the patient in left lateral decubitus with hips and knees flexed, the sacrococcygeal area was sterilized with povidone-iodine solution. The sacral hiatus was localized and punctured using short 1-inch 23-gauge needle until touching the ventral wall of sacrum, inclined until loss of resistance is encountered due to dural puncture, putting it horizontally and then advanced cephalad while aspirating. After confirmation of correct placement of the needle by injection of 1to 2ml of air while stethoscope was fixed over lumbar vertebrae, the anesthetic solution was injected slowly with frequent aspirations during injection, the anesthetic solution was a mix of bupivacaine 0.5% in dose [1 mg\kg] and lidocaine 2% in dose [3 mg\kg], the volume of injected solution was calculated by the equation: [volume in ml = 0.1 x bodyweight x number of segments to be blocked].

**Procedures:**

1. Assessment of sensory block; effectiveness and duration of sensory block had been assessed by an observational pain-discomfort scale [OPS]. The OPS assesses objectively behavioral parameters [crying, position of the torse, facial expression, the position of the legs and motor restlessness] each parameter is given a score 1-3 [none, moderate or severe] to give a total score of 5 - 15 to determine the quality of analgesia [5= excellent and 15=ineffective].
2. Assessment of motor block; intensity and duration of motor block had been assessed using a modified Bromage score; [0] Free leg movement and feet with the capability to raise extended leg; [1] The inability to raise the extended leg and reduced knee flexion; [2] Inability to raise the extended leg or flex the knee, with preservation of ankle and feet flexion; [3] Inability to raise leg, flex knee, or ankle.
3. Hemodynamics: heart rate and mean arterial blood pressure.
4. Assessment of postoperative pain and need of analgesia using Wong-BAKER facial Grimace scale in response to firm skin pinch to the dermatomal level after a child is awake and every 15 minutes in the 1st hour, every 1 hour for 4 hours then every 2 hours for 24 hours.

**Statistical analysis:** Data entry and statistical analyses were performed using SPSS [statistical package of social sciences] version 21 [SPSS Inc., Chicago, IL, USA] Continuous normally distributed data were expressed in mean and standard deviation. The quantitative data were examined by the Kolmogorov Smirnov test for the normality of data. An independent sample t-test [student t-test] was used for continuous normally distributed data. Statistical significance was considered when the probability [P] value was less than or equal to 0.05.

## RESULTS

The demographic character of our study groups was as following for group **C:** the mean age was 5.7±1.7 years, 70% were males, and for group **S:** the mean age was 6.45±1.3 years and 80% were males. There were no significant differences between both groups regarding age and sex [p= 0.22; 0.72] respectively.

Regarding the Sensory block, **Table [1]** shows that there was a highly significant statistical difference between both groups at first and second hours using an observational pain-discomfort scale [OPS], group [C] has a more effective sensory block than group [S].

For motor block Bromage scores, there was a significant statistical difference between both groups at 90 minutes and highly statistical difference between both groups at 120 and150 minutes; group [C] has more duration and intensity of motor block than group [S] as shown in the **table [2]**.

Considering Heart rate, there was a significant statistical difference at all times except at 15 and 45 minutes, where there was insignificant statistical difference. Also, the heart rate in both groups was significantly higher when compared to the baseline to 20 minutes as we give atropine as a pre-medication, while there was no significance until 60 minutes [detailed results presented in **table 3].**

Table [4] showed that, there was no significant statistical difference between both groups according to mean arterial blood pressure. Also, mean arterial blood pressure readings in both groups significantly lower when compared to the baseline to 30 minutes, while there was no significance until 60 minutes.

According to the Wong-Baker facial grimace scale, there was a highly significant statistical difference between both groups at 2, 3, 4, and 5 hours as regard post-operative pain**.** In addition, there was a statistically significant difference between both groups at 17 hours, group [C] has better post-operative analgesia than group [S] as illustrated in **[table 5]**.

**Table [1]:** [Table 1]: Effectiveness of sensory block between both groups:

| | | Group [C] [n] [%] | Group [S][n] [%] | P-value |
|---|---|---|---|---|
| **At emergence** | 5 | 14 [70%] | 15 [75%] | 0.54 |
| | 6 | 5 [25%] | 4 [20%] | |
| | 10 | 1 [5%] | 0 [0%] | |
| | 12 | 0 [0%] | 1 [5%] | |
| **At the first hour** | 5 | 7 [35%] | 0 [0%] | <0.001** |
| | 6 | 10 [50%] | 4 [20%] | |
| | 7 | 1 [5%] | 5 [25%] | |
| | 8 | 1 [5%] | 10 [50%] | |
| | 10 | 1 [5%] | 1 [5%] | |
| **At second hour** | 5 | 1 [5%] | 0 [0%] | <0.001** |
| | 6 | 8 [40%] | 0 [0%] | |
| | 7 | 8 [40%] | 0 [0%] | |
| | 8 | 3 [15%] | 7 [35%] | |
| | 9 | 0 [0%] | 1 [5%] | |
| | 10 | 0 [0%] | 6 [30%] | |
| | 12 | 0 [0%] | 3 [15%] | |
| | 13 | 0 [0%] | 2 [10%] | |

Table [2]: Motor block between both groups according to Bromage score [median and range]

| | **Group [C]** | | **Group [S]** | | **P-value** |
|---|---|---|---|---|---|
| | **Median** | **Range** | **Median** | **Range** | |
| **Baseline** | 3 | 0 – 3 | 3 | 0 – 3 | |
| **30 min** | 3 | 0 – 3 | 3 | 0 – 3 | |
| **60 min** | 3 | 0 – 3 | 3 | 0 – 3 | |
| **90 min** | 3 | 0 – 3 | 2 | 2 – 3 | 0.021* |
| **120 min** | 3 | 2 – 3 | 1 | 0 – 1 | 0.00** |
| **150 min** | ٢ | 1 – 2 | 0 | 0 | 0.00** |
| **180 min** | ١ | 0 – 1 | | | |
| **210 min** | 0 | 0 | | | |

Table [3]: Heart rate [beat/min] in both groups [mean ±SD]:

| | Group [C] | Group [S] | P-value |
|---|---|---|---|
| | Mean ±SD | Mean ±SD | |
| **Baseline** | 118.7±9.1 | 113.0±9.9 | 0.06 |
| **5 min** | 134.0±7.08 | 126.7±8.65 | 0.006* |
| **10 min** | 131.4±7.70 | 125.2±10.26 | 0.038* |
| **15 min** | 130.9±6.55 | 123.7±10.48 | 0.07 |
| **20 min** | 126.8±8.78 | 119.2±10.90 | 0.02* |
| **25 min** | 122.9±8.36 | 114.2±10.33 | 0.005* |
| **30 min** | 123.2±7.6 | 114.1±10.99 | 0.004* |
| **35 min** | 121.6±8.76 | 114.2±9.96 | 0.017* |
| **40 min** | 121.3±8.06 | 113.3±12.24 | 0.020* |
| **45 min** | 120.9±9.56 | 114.8±10.76 | 0.06 |
| **50 min** | 121.6±10.01 | 114.8±9.88 | 0.036* |
| **55 min** | 120.6±9.41 | 113.7±9.44 | 0.024* |
| **60 min** | 120.6±9.14 | 114.0±10.18 | 0.037* |

Table [4]: Mean arterial blood pressure [mmHg] in both groups [mean±SD]:

| | Group [C] | Group [S] | P-value |
|---|---|---|---|
| | Mean ±SD | Mean ±SD | |
| **Baseline** | 80.7±5.91 | 83.0±5.23 | 0.19 |
| **5 min** | 73.1±5.93 | 75.9±5.76 | 0.13 |
| **10 min** | 74.2±4.97 | 76.0±5.20 | 0.26 |
| **15 min** | 76.1±4.35 | 78.6±5.45 | 0.11 |
| **20 min** | 76.6±5.24 | 79.2±5.62 | 0.14 |
| **25 min** | 77.6±5.89 | 79.7±5.73 | 0.25 |
| **30 min** | 77.9±5.08 | 79.5±5.71 | 0.37 |
| **35 min** | 79.6±6.13 | 82.7±3.25 | 0.06 |
| **40 min** | 79.6±5.16 | 82.2±5.16 | 0.13 |
| **45 min** | 80.6±6.26 | 82.2±4.27 | 0.73 |
| **50 min** | 80.6±5.29 | 82.3±5.49 | 0.31 |
| **55 min** | 81.0±5.93 | 82.3±3.96 | 0.44 |
| **60 min** | 81.0±5.93 | 82.9±4.69 | 0.28 |

Table [5]: Post-operative pain between both groups according to Wong-Baker facial grimace scale [median and range]:

| | Group [C] | | Group [S] | | P-value |
|---|---|---|---|---|---|
| | **Median** | **Range** | **Median** | **Range** | |
| **15 min** | 0 | 0 – 2 | 0 | 0 – 2 | |
| **30 min** | 0 | 0 – 2 | 0 | 0 – 2 | 0.36 |
| **45 min** | 0 | 0 – 0 | 0 | 0 – 2 | 0.15 |
| **1 hrs** | 0 | 0 – 2 | 0 | 0 – 2 | 0.44 |
| **2 hrs** | 0 | 0 – 2 | 5 | 2 – 9 | 0.00** |
| **3 hrs** | 0 | 0 – 2 | 2 | 1 – 4 | 0.00** |
| **4 hrs** | 0 | 0 – 6 | 3 | 2 – 5 | 0.00** |
| **5 hrs** | 3 | 3 –10 | 3 | 2 – 6 | 0.00** |
| **7 hrs** | 4 | 2 – 7 | 4 | 3 – 5 | 0.46 |
| **9 hrs** | 3 | 2 – 5 | 4 | 2 – 6 | 0.22 |
| **11 hrs** | 4 | 2 – 7 | 4 | 2 – 7 | 0.95 |
| **13 hrs** | 5 | 2 – 8 | 4 | 2 – 7 | 0.8 |
| **15 hrs** | 5 | 2 – 7 | 4 | 2 – 7 | 0.87 |
| **17 hrs** | 4 | 2 – 6 | 3 | 0 – 5 | 0.022* |
| **19 hrs** | 3 | 1 – 5 | 3 | 1 – 6 | 0.97 |
| **21 hrs** | 3 | 0 – 5 | 4 | 1 – 8 | 0.28 |

## DISUCSSION

In the current literature age, weight and sex are not restricting factors for spinal or caudal anesthesia. The opinion of the surgeons on regional anesthetic techniques varied between good and excellent[5]. In this study, bupivacaine has used alone at a dosage of 0.5 percent and enough volume to render an effective anesthetic plane for lower abdominal surgery. **Lopez et al.**[7] showed hyperbaric bupivacaine 0.5%, 0.5% ropivacaine, 0.5% levo-bupivacaine were used for spinal anesthesia in children 1-14 years of age. Isobaric lidocaine 2% was reported but not recommended due to the short duration of action.

**Dohi and Seino**[5] have shown stable hemodynamic in children up to age of 5 years with regional anesthesia. Above 6 years of age, a mild reduction of blood pressure had been observed, and a more marked blood pressure reduction had been registered at the age between 8 and 15 years. The present study recorded fewer changes in arterial blood pressure in both groups, with more tachycardia among the caudal group.

Factors involved in this hemodynamic stability with regional anesthesia in pediatrics are not yet established. One hypothesis is that the relative immaturity of the sympathetic nervous system, the lower vasomotor tone, and the lower capacitance veins in the lower extremities. Heart rate was held at normal range because regional anesthesia prevents bradycardic response to mesenteric or spermatic cord manipulation during urogenital surgery or lower abdominal surgery[8].

In the present study, we recorded longer duration of analgesia with caudal than spinal group, which is comparable to **Blaise and Roy**[9]. In agreement with the present study, **Williams et al.**[10] showed that spinal anesthesia is associated with 90 minutes duration of analgesia after spinal approach in children, which limits its use for longer surgeries.

Also, in the current study, the post-operative analgesia duration after caudal anesthesia was approximately 300 minutes which is comparable to **Klimscha et al.** [11] who found that mean duration of analgesia in caudal anesthesia using bupivacaine only was 346 minutes, and with epinephrine was 300 minutes and 360 minutes in children received caudal with clonidine. On the other hand, **Murni et al.** [12] test the length of postoperative analgesia in three groups aged 1-7 years, caudal group utilizing just 0.25 percent bupivacaine, caudal with epinephrine and caudal with clonidine. The mean duration of post-operative analgesia was 460 minutes in patients receiving bupivacaine caudal alone, 377 minutes in children receiving epinephrine caudal, and 987 minutes in children receiving clonidine caudal as an adjuvant.

**Devendra et al.** [1] studied spinal anesthesia in 102 children [6 months to 14 years old] scheduled for infra-umbilical and lower limb surgeries using hyperbaric bupivacaine 0.5% in a dose of 0.5 mg/kg [for child < 5 kg], 0.4 mg/kg [for 5-15 kg], 0.3 mg/kg [for >15 kg]. Spinal anesthesia was successful in 98% of cases. Modified Bromage score was [3] in 98% of patients with a mean time to return Bromage score to 0 was 111.95 ± 20.54. The mean duration of surgery was 52.5 ± 16.056 min. Complications were minimal with hypotension occurring in 2 [2%] and shivering in 3 [2.9%] patients.

**Saint and Schulte**[13] reported that subarachnoid anesthesia has been shown to have the advantage of being effective in the first 2 minutes compared to caudal anesthesia.

Regional anesthesia in suffering, distressed child may be detrimental to sensitive neurovascular structures and should be avoided. The majority of children need extra-sedation [ketamine, midazolam, thiopentone, propofol, halothane, sevoflurane, or nitrous oxide]. In accordance with the present report, we are providing midazolam and sevoflurane to promote the treatment [14].

**Andreas et al.**[15] have shown that the placement of regional anesthetic blocks in pediatric patients under GA is safe as in sedated and awake children.

In short, results of the current work revealed that, caudal and spinal, both are effective, however caudal have relatively more duration of postoperative analgesia and motor block than spinal anesthesia. Thus, caudal anesthesia could be preferred than spinal anesthesia for lower abdominal surgeries for children

**Financial and Non-Financial Relationships and Activities of Interest**

None

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