A Comparative Study between Spinal and General Anesthesia in Infants and Children Undergoing Surgical Procedures in the Lower Half of the Body

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Abstract: The objectives of spinal block in infants and children are analgesia and muscle relaxation with minimal physiological disturbances, rapid recovery and prevention of side effects and complications associated with general anesthesia. The present study was designed to compare between spinal and balanced general anesthesia in infants and children undergoing surgical procedures in the lower half of the body. One of the targets of the study is to gain some popularity for spinal anesthesia in infants and young children in our practice. This study was performed in Tanta University Hospitals after obtaining the local hospital organization approval. Sixty patients of both sex classified as ASA physical status I and II, aged between 2 months – 6 years scheduled for general surgical, orthopedic and urological procedures in the lower half of the body were enrolled in the study after an informed written consent was obtained from the parents. Patients were randomized into two equal groups: **Group S** (spinal anesthesia group): Patients received lumbar subarachnoid block with hyperbaric bupivacaine 0.5% after induction of general anesthesia. **Group G** (general anesthesia group): Patients received balanced general anesthesia (control group). The hemodynamic parameters and the sensory and motor characteristics of the spinal block, as well as the ease of performance and success rate of the block were assessed. Also the recovery time, the postoperative pain scores, and the total doses of fentanyl consumed postoperatively were recorded. Blood samples for measurement of serum cortisol, adrenaline, noradrenaline and glucose were taken immediately preoperatively, 45 minutes after beginning of surgery and 2 hours postoperatively. The stress hormones and glucose values were significantly higher in Group G, when compared with Group S, 45 minutes after surgery. The postoperative pain scores at recovery, as well as the postoperative fentanyl consumption, were significantly higher in Group G as compared to Group S. On the contrary, the recovery time in Group S was significantly higher than that observed in Group G. The block characteristics in Spinal anesthesia group showed almost complete motor block in all patients well before 5 minutes from onset of SAB which started to resolve after 56±9 minutes. The upper level of sensory block was achieved well before 10 minutes in all patients and reached on average to T5. The overall complications related to spinal anesthesia were infrequent and minor. **In conclusion:** Spinal block in children less than 6 years of age is safe, practical and satisfactory in surgery involving lower half of the body provided that the anesthetist is experienced with a good and well- informed assistant. Onset time of pediatric spinal is short and the block is characteristically of excellent sensory quality and usually adequate muscle relaxation especially for lower abdominal and orthopedic procedures.

Key words: (SAB) Subarachnoid Block,(Pka) dissociation constant, (NIBP) non-invasive blood pressure.

1. Introduction

Spinal anesthesia produces a profound and uniformly distributed sensory block with rapid onset and good muscle relaxation, and it results in more complete control of cardiovascular and stress responses than epidural or opioid anesthesia (Dalens JB. 2010). Because of these benefits, spinal anesthesia has gained acceptance for children undergoing surgery in the lower part of the body . *(*Giaufre *et al.* ,1996 *and* Williams *et al*., 2006)). Epidemiological data suggests that infants are at an increased risk of complications associated with general anesthesia as compared with older children and adult infant. Spinal anesthesia has been associated with a decreased incidence of hypotension, hypoxemia, bradycardia, or postoperative apnea compared with general anesthesia(**Kokki H., 2000**).The pharmacologic properties of available local

anesthetics are fully evaluated, even in neonates, and the fear of nerve lesions and neurologic sequelae has proved unfounded as confirmed by a recent prospective study involving 24,409 children given a regional block (**Giaufre *et al.,* 1996**). Although plexus and conduction nerve block are still underused, they have elicited increasing interest because they provide localized analgesia with small amount of local anesthetic. Two scientific discoveries have reinforced this interest. First, peripheral nervous system sensitization plays a considerable role in sustaining postoperative pain and can be prevented only by conduction nerve block. Second, opioids have pronociceptive effects that are relevant when their administration is discontinued. These effects are proportional to the given doses and duration of treatment. These data strongly incite practitioners to use regional block instead of opioid

analgesia. Additionally, the use of regional anesthesia reduces the cost of patient care. (**Dalens, 2010**). However, infant spinal anesthesia remains underutilized relative to general anesthesia and can indeed be a safe alternative to general anesthesia in the pediatric age group.

The present study was designed to compare between spinal and balanced general anesthesia in infants and children undergoing surgical procedures in the lower half of the body. One of the targets of the study is to gain some popularity for spinal anesthesia in infants and young children in our practice.

2-Patients and Methods

The current study was performed in Tanta University Hospitals after obtaining the local hospital organization approval. Sixty patients of both sex classified as ASA physical status I and II, aged between 2 months – 6 years, weighing from 4.5 – 20.5 kilograms, and scheduled for surgical procedures in the lower half of the body were included in the study. Full explanation of the procedure, possible side effects and complications, were discussed before an informed written consent was obtained from the parents.

Patients were randomized into two equal groups of thirty patients in each group:

Group S *(spinal anesthesia group)*: Patients received lumbar subarachnoid block with hyperbaric bupivacaine 0.5% after induction of general anesthesia.

Group G *(general anesthesia group)*: Patients received balanced general anesthesia.

Exclusion criteria:

Coagulopathy and other hemorrhagic diatheses, Hypovolemia, Spinal deformity and children with neurological disorders and Allergy to bupivacaine or other local anesthetics. Diet was unrestricted until 4 – 6 hours preoperatively.

Clear fluids were encouraged until 2 – 3 hours before induction. Preoperative sedation was achieved by oral midazolam (Dormicum ™ 5mg/ml solution, Roche) 0.5 mg/kg (maximum 5 mg) 30 to 60 minutes before admission to the operating room.

Materials:

- Cardiopulmonary resuscitative drugs e.g. atropine, epinephrine and ephedrine.
- NIHON KOHDEN BSM-2301K (Japan) non-invasive vital signs monitoring system.
- Hyperbaric bupivacaine 0.5% (Heavy Marcaine™, Astra Zeneca, Finland) solution for injection.
- 22- 25 G spinal needles; short (2.2-5 cm) and standard length (9 cm).
- 27 G hypodermic 1ml and 24 G 3 ml volume syringes.
- Facilities for general anesthesia: anesthesia machine, suction machine, endotracheal tubes, laryngeal mask airways, laryngoscope with blades of different sizes

and anesthetic drugs as thiopental sodium, propofol, skeletal muscle relaxants, and volatile anesthetics.

Anesthetic technique:

Monitoring was accomplished with a precordial stethoscope, noninvasive blood pressure cuff (NIBP) placed over the thigh to minimize restlessness with repeated cuff inflations, ECG and ventilatory frequency, and peripheral arterial oxygen saturation using a pulse-oximetry probe (SpO2). Measurements was recorded before performing lumbar puncture or induction of general anesthesia, 5 minutes after administration of the spinal anesthetic or after endotracheal intubation, and every 10 minutes thereafter for one hour or till the surgical procedure had been finished.

On arrival to the operating room a peripheral venous cannula was inserted, and maintenance warmed intravenous lactated Ringers' solution was infused with the following rate:

Up to 10 kg: 4ml/kg/hr

10 - 20kg: 2ml/kg/hr were added to the previous amount.

More than 20 kg: 1ml/kg/hr were added to the previous amount.

Also the amount calculated for the fasted hours was given, divided equally in the first and second operative hours. Any blood loss was given as appropriate.

In Group S, the anesthetic technique started with the inhalation of 2 – 3% halothane in oxygen via the face mask till the patient had been heavily sedated, then the patient was placed in the lateral decubitus position. Following skin preparation with povidone-iodine solution and 70% ethyl alcohol, one of the L4-5 or L5-S1 interspaces was chosen and the overlying skin was infiltrated with 1% mepivacaine solution using a hypodermic syringe with a 27-gauge needle.

Lumbar puncture was done using a midline approach with an appropriate spinal needle, with the bevel of the needle facing laterally parallel to the longitudinal dural fibers. Correct placement of the needle was verified by free flow of CSF. The syringe containing the appropriate dose of bupivacaine plus the dead space of the needle (approximately 0.2 ml) was previously prepared. After injection of the local anesthetic over 10 seconds, free aspiration of CSF was again verified. The inhalation anesthesia then was discontinued, and the child was immediately placed in the supine position with a 20 to 30° head up position for 2 to 3 minutes and then horizontally. After the inhalation anesthesia had been discontinued, the patients breathed oxygen via the face mask for 2-3 minutes then low flow oxygen was administered via nasal prongs.

The patients legs were not allowed to be raised (e.g. to apply the cautery pad), so as to avoid a high block that might ensue.

The spinal local anesthetic drug used was hyperbaric bupivacaine 0.5% in 8% dextrose solution. The dose injected was based on body weight (B.W.) as the following:

B.W. ≥ 20 kg; the dose is 0.25 – 0.3 mg/kg.
B.W. = 10 – 19 kg; the dose is 0.4 mg/kg.
B.W. < 10 kg; the dose is 0.5 – 0.8 mg/kg.

The spinal block was judged to be adequate if a lack of response to firm skin pinch at the dermatomal level appropriate for the surgical procedure had been present, together with observation of a profound motor weakness or paralysis in the lower extremities. If, initially, signs of inadequate anesthesia (e.g. Motor reaction to skin incision, increase in heart rate, arterial blood pressure or respiratory rate) had been present, intravenous fentanyl or GA were given for supplementary analgesia. This was recorded and the case was designated as failed spinal block. Also if the surgical procedure outlasted the duration of the block supplemental analgesia was be given and recorded.

Patients who were too anxious or feeling uncomfortable (e.g. crying) after premedication or during operation were sedated with an intravenous boluses of thiopentone sodium 1-2 mg/kg or propofol 0.5-1 mg/kg. The need for additional sedation was recorded.

In group G, GA was induced with inhalation of 2– 3% halothane in oxygen till the eyelash reflex had been lost. This was followed by intravenous bolus of fentanyl 1 μg/kg and intravenous injection of atracurium 0.5 mg/kg to facilitate oro-tracheal intubation which was attempted after a period of assisted manual ventilation for 2-3 minutes. Anesthesia was maintained with isoflurane in oxygen, with intermittent boluses of fentanyl and atracurium. The patients were mechanically ventilated using a standard anesthesia machine (Blease Frontline 560) with a tidal volume of 8 ml/kg with an inspiratory /expiratory ratio of 1:2. The respiratory rate ranged from 12 to 20 cycles/minute. Dose adjustment of isoflurane, fentanyl, and atracurium was based on standard clinical signs and hemodynamic measurements (heart rate, arterial pressure, pupil size, lacrimation and sweating). After the surgery had been completed, the inhalation anesthesia was discontinued and the patients were allowed to recover spontaneously on pure oxygen. Extubation was done after reversal of muscle relaxation using intravenous neostigmine 0.05 mg/kg with atropine 0.02 mg/kg.

Recovery from anesthesia:

Immediately after recovery all patients were given diclofenac sodium 2 mg/kg rectally, as a basal analgesic, and transferred to the recovery room breathing room air. Fentanyl 0.5 μg/kg was given IV to

children with pain scores (on the *modified observational pain score*) of 6 or more as a rescue analgesic. This was recorded as well as the total dose consumed.

Children were observed till being fully awake, with stable vital signs for at least 1 hour, having no or mild pain, able to walk unaided or with minimal assistance in walking children , with no or minimal nausea and vomiting and tolerating clear oral fluids. The time to meet these criteria from the end of surgery (*recovery time*) was recorded as well as the occurrence of any adverse effects related to the anesthetic technique used.

Data collection:

1. Hemodynamic parameters:

Heart rate (HR), non-invasive blood pressure (NIBP), and peripheral arterial oxygen saturation (SpO2) were recorded for all patients at these times:

Before performing LP or induction of GA.

Five minutes after administration of the spinal anesthetic or after endotracheal intubation.

Every 10 minutes for one hour.

2. Sensory Assessment: This was done to quantify the following:

The upper level of anesthesia (sensory level): this was determined by attempting to elicit a grimace or acknowledgement of pain to bilateral pin prick at each dermatome at 5 and 10 minutes after the local anesthetic had been injected.

Time to two segment regression (T2seg): this was assessed before transferring the child to the recovery room by attempting to elicit a grimace or acknowledgement of pain to bilateral pin prick.

3. **Motor Assessment:** using (Bromage PR.2002) Scale:

0 = Able to raise straight leg, full flexion of knee and feet.
1 = Inability to raise leg, able to flex knees.
2 = Inability to flex knees, able to flex ankles.
3 = Inability to flex ankles

Two events were recorded; the time and degree of maximal motor block after SAB, as well as the time at which the early return of muscle power was first observed after SAB e.g. return of movement of the lower limb. This was referred to as duration of anesthesia.

4- Ease of Performance and Success Rate:

The ease of performance was evaluated according to the number of trials by which the procedure could be achieved.

The *success rate* of the procedure was evaluated according the following criteria:

1. Successful block: This required the absence of any gross purposeful muscular movement and the absence of an increase in BP or HR of more than

20% compared with baseline values in reaction to the surgical incision.

2. Failed block: This requires the presence of gross purposeful muscular movement and an increase in BP or HR of more than 20% compared with the baseline values obtained just before the surgical incision. The case was recorded as ***failed spinal*** and excluded from statistical analysis. Rescue analgesia was administered with induction of balanced general anesthesia.

5- Complications:

Any complications such as (bradycardia, hypotension, apnea, desaturation, shivering, headache, stiffness of the neck, weakness of lower limb, urine retention or nausea and vomiting) were recorded and analyzed.

6-Analgesic effectiveness and fentanyl consumption:

A modified observational pain scale (OPS) (**Hannallah *et al.*, 1987**)was used to evaluate analgesic effectiveness. The OPS assesses behavioral objective parameters (Crying, Agitation and Movements) with changes in Systolic blood pressure (a physiological parameter). Each parameter is given a score of 0-2 to give a cumulative score of 0-8. Additionally older children who could state that they felt pain (a subjective parameter) were awarded extrapoints; one, if they reported pain but could not localize it and two, if they were able to localize the pain either verbally or by pointing. If the OPS score, assigned by resident doctors, was 6 or higher, or the patient had obvious signs of pain e.g. localization or verbalization, the rescue analgesic medication (fentanyl 0.5 µg/kg) was given intravenously. This dose might be repeated, in the same episode, till pain scores had been less than 4 (e.g. 3) or the patient had shown a satisfactory response. Pain scores were assessed just before transferring the children to the recovery room (or immediately on arrival to it) *(P recovery)*, one *(P 1st hr)* and two hours *(P 2nd hr)* afterwards. The number of doses of fentanyl consumed postoperatively was recorded.

7-Blood sample collection:

Blood samples for measurement of serum cortisol, adrenaline and noradrenaline were taken immediately preoperatively, 45 minutes after beginning of surgery and 2 hours postoperatively (after the child has been transferred to the recovery room).

Whole blood sugar was assayed at the same times using a standard bedside glucometer (GlucoDr™) using blood from finger or toe with 27 G needle prick.

Catecholamines were assayed by CatCombi ™ ELISA, IBL, Hamburg, Germany.

Cortisol assay was accomplished with Cortisol ELISA, a competitive immune-enzymatic colorimetric method for quantitative determination of cortisol concentration in serum and plasma, provided by

DIAGNOSTIC AUTOMATION, INC. Calabasas, CA91302 USA.

Statistical Analysis:

The findings of the two groups were statistically analyzed and compared using SPSS version 12 (SPSS Inc., Chicago, IL). Mean and standard deviation (mean±SD) were performed for numerical data. Continuous variables (e.g. the results for arterial BP, heart rate, SpO_2, and blood chemistry) were compared using the unpaired Student's t-test. Nominal non-parametric data were analyzed with the chi-square test. Frequency and percentages were used also for categorical data. *P*-values < 0.05 were considered as statistically significant.

3-Results

The current study was performed in Tanta University Hospitals on sixty patients of both sex aged between 2 months – 6 years, weighing from 4.5 – 20.5 kilograms, and scheduled for surgical procedures in the lower half of the body. Patients were randomized into two equal groups:

- Group S (spinal anesthesia group): Patients received lumbar subarachnoid block with hyperbaric bupivacaine 0.5% after induction of general anesthesia.

- Group G (general anesthesia group): Patients received balanced general anesthesia.

Demographic data of the two groups of patients showed no statistically significant difference ($P > 0.05$) as regards age, weight, and sex distribution **(Table1).**

In Group G the mean age was 30.6±21.8 months. Regarding weight, the mean of 12.7 ± 4.5 kgs. Male to female ratio was 22/8. In Group S the mean age was 28.8 ± 21months. Regarding weight, the mean of 12.4 ± 4.2kgs. Male to female ratio was 23/7

Types and durations of operations:

In group G 15 patients underwent congenital hernia repair, 1 circumcision, 8 hypospadius repair, 2 hydrocele repair, and 4 orthopedic surgeries.

In Group S 12 patients underwent congenital hernia repair, 7 circumcision, 4 hypospadius repair, 1 hydrocele repair, and 6 orthopedic surgeries.

Regarding the duration of surgical procedures, it was in 42.5±9.4 minutes in Group G, while it was 35.8±12.3 minutes in Group S. There was no statistical significance between the two studied groups as regard the durations of surgical procedures.

Changes in systolic blood pressure (sBP) (mmHg) in all studied times:

The preoperative mean value of sBP in Group G was 98.4±6.5 mmHg which significantly increased (P< 0.05) to a mean value of 100.6±6.8 mmHg five minutes after intubation. In Group S, the preoperative mean value of sBP was 100.9±8.9 mmHg which significantly decreased (*P*< 0.05) to a mean value of 96.3±8.5 mmHg five minutes after SAB.

There was significant reduction of systolic BP (*P*< 0.05) in Group S 5 minutes after SAB when compared to Group G mean value at the corresponding time.

Changes in peripheral arterial oxygen saturation in all studied times:

The preoperative mean value of peripheral arterial oxygen saturation in Group G and Group S were (97.7±1.0 % and 97.7±1.1 % respectively)which underwent insignificant changes throughout the studied times.

Changes in plasma noradrenaline (pg/ml) in all studied times:

Table 2 shows that the preoperative mean value of plasma noradrenaline in Group G was 319.3±93.4 pg/ml which rose significantly (*P*< 0.05) to mean values of 576.7±87.3 and 503.7±68.6 pg/ml at 45 minutes after intubation and at two hours post-operatively respectively, in Group S. There was a single significant rise (*P*< 0.05) of the mean value of plasma noradrenaline measuring 427.5±125.5 pg/ml at 2 hours post-operatively when compared with the preoperative mean value of 330.0±94.8 pg/ml.

Changes in plasma adrenaline (pg/ml) in all studied times:

The preoperative mean value of plasma adrenaline in Group G was 55.8±13.6 pg/ml which rose significantly (*P*< 0.05) to mean values of 113.4±21.0 and 140.9±20.0 pg/ml at 45 minutes after intubation and two hours post-operatively respectively.

Group S. There was a single significant rise (*P*< 0.05) of the mean value of plasma adrenaline measuring 97.9±18.3 pg/ml at 2 hours post-operatively when compared with the preoperative mean value of 55.9±15.2 pg/ml.

Changes in serum cortisol (μg/dl) in all studied times:

There was a statistically significant difference (*P*< 0.05) between the two studied groups at 45 minutes after intubation or SAB with the mean values of 33.9±9.3 and 18.0±3.6 μg/dl in Group G and Group S respectively.

Changes in blood glucose (mg/dl) in all studied times:

There was show a statistically significant difference (*P*< 0.05) between the two studied groups at 45 minutes after intubation or SAB with the mean values of 108.9±14.0 and 72.5.3±5.34 mg/dl in Group G and Group S, respectively.

Changes in postoperative pain scores in all studied times:

The mean value of postoperative pain score at recovery (P recovery) in Group G was 3.83±1.12 which increased significantly (*P*< 0.05) after 1 hour to reach 4.90±1.18, then decreased significantly (*P*< 0.05) after 2 hours to a mean value of 2.30±0.65.

In Group S was1.39±0.79 which increased significantly (*P*< 0.05) after 1 hour and 2 hours to reach record mean values of 4.14±1.11 and 2.32± 0.78, respectively.

The postoperative mean values of pain scores at recovery were significantly higher (*P*< 0.05) in Group G when compared to Group S at the same time. Similar increase in Group G was noted after 1 hour but this was not statistically significant (*P*> 0.05).

Postoperative fentanyl consumption:

The postoperative fentanyl consumption in Group G was 0.73±0.79 dose which is significantly higher (*P*< 0.05) than the mean value of 0.39 ±0.57 dose in Group S. Each dose administered was calculated based on body weight as 0.5 μg/kg.

Duration of recovery time:

The duration of recovery time in Group G was 1.47±0.41 hours which is significantly lower (*P*< 0.05) than that of 1.93±0.56 hours in Group S.

Subarachnoid block characteristics in Spinal anesthesia group:

Evaluation of sensory level

After 5 minutes from the onset of SAB, the upper level of sensory block evaluated ranged from 2nd thoracic segment (T2) to 7th thoracic segment (T7) with a mean value of 5±1 (refers to the 5th thoracic segment ± one segment). Evaluation of upper sensory level after 10 minutes from the onset of SAB was not changed from the previous values obtained after 5 minutes indicating that the maximal level was already established after 5 minutes from onset of SAB.

Time to two segments Regression (T2seg)

The time elapsed from the onset of SAB till the upper level of sensory block had receded two segments ranged from 55 to 90 minutes, with a mean value of 68.75 ±8.12 minutes.

Degree (Bromage score) and time to establishment of maximal motor block

The maximal intensity of motor block, assessed by Bromage score, ranged from 2 to 3 with a mean of 2.86±0.36.

The time passed from the onset of SAB to establishment of the maximal degree of motor block ranged from 2.5 to 4.5 minutes, with a mean of 3.41±0.43 minutes.

Duration of anesthesia (Also referred to as duration of motor block or Time to early return of movement) the duration of motor block ranged from 45 to 85 minutes with a mean of 56.19±8.72 minutes.

Evaluation of the ease of performance and success rate of SAB and the need for intraoperative IV sedation.

Table 3 shows that the subarachnoid space was identified (as evidenced by free flow of CSF) from the 1st attempt of lumbar puncture (LP) in 16 patients (53%), from the 2nd attempt in 10 patients (33%), and from the 3rd attempt in 4 patients (14%).

Spinal anesthesia was successful in 28 patients (93%), while failed in 2 patients (7%) .

As regards intraoperative intravenous sedation, it was necessary in 19 patients (68%) to complete the surgery. **(Table 4)**

Evaluation of perioperative complications:

The incidence and types of perioperative complications among patients of the study groups. **In Group G,** two patients (7%) had desaturation (SpO$_2 \leq$ 92%), one (4%) suffered from shivering, and six patients (20%) vomited. No patient had suffered from headache or urine retention.

In Group S, two patients (7%) suffered from shivering, one (4%) vomited, one (4%) had urine retention, and one (4%) complained from position dependent headache. No patient in the study had hypotension or bradycardia. **(Table 5)**

Table 1- Demographic data (mean±SD, numbers and percentages) of the studied patients in the different groups

		Group G No. & (%)	Group S No. & (%)	*P*-value
Age(months)	Range	2-70	2-72	0.745
	Mean ± SD	30.6±21.8	28.8±21	
Sex	Male	22(73%)	23(76%)	0.766
	Female	8(27%)	7(24%)	
Weight (kg)	Range	4.5-20.5	4.8-20.3	0.790
	Mean ± SD	12.7±4.5	12.4±4.2	

Table 2- Comparison of changes in plasma noradrenaline level (pg/ml) between groups

Noradrenaline (pg/ml)				
Time	Group G	Group S	T-test	
			t	*P* - value
	Mean ± SD	Mean ± SD		
T0 Pre-operative	319.333 ± 93.438	330.000 ±94.829	-0.431	0.668
T1 45 min after intubation or SAB	576.667 ±87.310	325.357±94.496	10.528	0.000*
T2 2hours post-operative	503.667 ±68.556	427.500±125.481	2.895	0.005*

(*) denotes statistically significant difference at *P*<0.05

Table 3. Evaluation of the ease of performance of SAB

Attempts of LP	No. of patients (total=30)	%
1st attempt	16	53
2nd attempt	10	33
3rd attempt	4	14

Table 4. Evaluation of success rate of spinal anesthesia and need for additional intraoperative sedation.

	No. of patients	%
Successful	28	93
Failed	2	7
Sedation i v	19	68
no sedation	9	32

Table 5- Incidence and types of perioperative complications among patients of the study groups.

Events	Group G		Group S	
	NO	%	NO	%
Hypotension	0	0	0	0
Bradycardia	0	0	0	0
Desaturation (SpO2 ≤ 92%)	2	6.7	0	0
Shivering	1	3.7	2	7
Vomiting	6	20	1	3.5
Headache	0	0	1	3.5
Urine retention	0	0	1	3.5

4-Discussion

Spinal anesthesia produces a profound and uniformly distributed sensory block with rapid onset and good muscle relaxation. Also it results in more complete control of cardiovascular and stress responses than epidural or opioid anesthesia. Because of these benefits, spinal anesthesia has gained acceptance for children undergoing surgery in the lower part of the body (**Williams *et al.*, 2006).**

The present study was performed to compare between spinal and balanced general anesthesia in infants, excluding neonates, and pre-school pediatric patients, undergoing day-case surgery of the lower half of the body. One of the targets of the study is to gain some popularity and familiarity with spinal anesthesia in infants and young children in our practice.

In the present study significant reductions in the heart rate and systolic blood pressure was noted five minutes after initiation of SAB. Although statistically significant, those changes were clinically insignificant being within normal range appropriate for age. Moreover, these changes were transient and short-lived, so that spontaneous correction was noticed after 15 minutes from SAB. None of our patients in the spinal anesthesia group required pharmacological interventions for treatment of hypotension or bradycardia.

Mahe *et al.*(1988) reported these hemodynamic observations transiently after spinal anesthesia and attributed those changes to the control values for heart rate and blood pressure that were higher than normal values for that age as some of the infants were crying before the insertion of the venous cannula, due to lack of premedication.

Another explanation may also account for these hemodynamic phenomena where in awake infants undergoing awake spinal anesthesia stability of blood pressure may be achieved by reduction of vagal tone to the sinoatrial node allowing a modest rise in heart rate in response to vasodilatation(**Craven *et al.*, 2003 and and Oberlander *et al.*, 1995).**

In the present study, the spinal block was not shown to depress the respiratory function as evidenced by normal arterial oxygen saturation (not less than 96%). No apnea was recorded in any of the patients during the course of the study.

The results of Spinal anesthesia group were in agreement with the study done by **Oberlander *et al.*(1995)** who recorded no respiratory changes after spinal anesthesia in former premature infants, even with high block reaching up to C7. Oxygen saturation remained 97% - 100% for all the subjects. Furthermore, there had been no reports of postoperative apnea following an uncomplicated spinal anesthetic in infants not receiving supplemental sedation or narcotic analgesic. On the other hand, in the general anesthesia group two patients (7%) had desaturation after

extubation (SpO$_2$ ≤ 92%). One of them suffered from stridor after extubation while the other had repeated breath holding attacks, both patients were treated by continuous positive airway pressure and intermittent positive pressure ventilation through the face mask. The results of the current study show, in Spinal anesthesia Group, that the concentrations of noradrenaline, adrenaline, and cortisol only increased 2 hours postoperatively, while this effect was not pronounced 45 minutes after subarachnoid block, a time when the sensory block was still active. On the other hand, a significant rise was evident in the General anesthesia Group at 45 minutes after intubation, as well as 2 hours postoperatively. Similar results were obtained by (**Krane *et al.,* 1995 and Humphreys *et al.,* 2005) .**

In the present study, the block characteristics in spinal anesthesia group showed almost complete motor block in all patients well before 5 minutes from onset of SAB which started to resolve after 56±9 minutes. The upper level of sensory block was achieved well before 10 minutes in all patients and reached on average to T5. The time to two segment regression was 69±8 minutes, LP was successful from the 1st or 2nd attempts in 86% of patients and spinal anesthesia was successful in 28 patients (93%). Intraoperative intravenous sedation was required in 19 patients (68%). A large number of studies on pediatric spinals reported a wide range of sensory and motor block characteristics. This discrepancy among trials aroused from differences in study design, type and volume of local anesthetics, methods of assessment of pain, inclusion of wide age range and surgical procedures having variable pain intensities. **Dalens (2010)** Reported success rates of spinal anesthesia in children range between 54 and 100%, but the lower success rates seem to be related rather to an inadequate duration of the block compared to the procedure, than to difficult placement.

In reports where spinal anesthesia has been used on minor or medium surgical procedures, the success rate is between 96 and 97% (**Puncuh *et al.,* 2006**). Comparisons between spinal and epidural anesthesia showed significantly better success rates in the spinal group (**Kokki and Hendolin, 1995**).Spinal puncture in children seems to be easier than in adults. Flexibility of the spine and easy detection of intervertebral spaces make subarachnoid injection quite simple (**Suresh and Hall, 2006).**Multiple studies report similar high success rate of LP and spinal anesthesia; **Frumiento *et al.*(2000)** performed spinal anesthesia for 269 preterm infants undergoing inguinal hernia repair with success rate 97.3%, and spinal placements were achieved from the first attempt in 91.4 %, and on the second attempt in 5.94 %. They stated that 78.6% of the patients did not require supplemental anesthesia.

In the present study, the reported complications in the spinal anesthesia group were minor and relatively low, the low complication record in our results is in agreement with **Puncuh *et al.*(2006)** who recorded the incidence and severity of complications to be low. Only 0.9 % of children less than 10 years of age and 4 % of children 10 years or older, developed hypotension. The incidence of postdural puncture headache was 0.4 % of children and backache was 0.7 %. No other neurological complications were recorded.

In conclusion spinal block in children less than 6 years of age is safe, practical and satisfactory in surgery involving lower half of the body provided that the anesthetist is experienced with a good and well-informed assistant. Many advantages of spinal anesthesia have been shown in the current study including; lack of hemodynamic or respiratory depression, a rapid onset of dense and universally distributed sensory and motor blockade, adequate early postoperative pain control that potentially could be augmented and extended with neuraxial medications. Spinal anesthesia when compared with general anesthesia appears to be more cost-effective due to lower drug and equipment costs and rapid turnover in the operating theatre. Thus, it may be an attractive option in developing countries with limited resources.

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4/21/2012