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Evaluation of the perioperative analgesic effects of caudal block for herniotomy in children at the University College Hospital Ibadan. Nigeria

OA Akinyemi and OA Soyannwo

Department of Anaesthesia, College of Medicine, University of Ibadan, and Ibadan. Nigeria

Abstract

Introduction: Caudal block is a commonly performed day case anaesthetic procedure in children for most infraumbilical surgeries worldwide [1] as it provides good analgesia in the perioperative period. In Nigeria there is paucity of data on caudal block hence the justification for this study.

Methods: This study compared the perioperative analgesic effects and safety profile of caudal block using 0.5 ml/kg body weight of 0.25% plain bupivacaine with light general anaesthesia (GA) versus inhalational GA alone in 60 children aged 2-10 years that had herniotomy using behavioural pain scale to access pain [2].

Results: Showed a mean duration of surgery ± standard deviation (SD) of 17±2 minutes for caudal, 51± 6 minutes for GA (t = 60, p < 0.05, df = 59). Mean recovery times postoperatively was 6 ± 2 minutes for caudal, 14 ± 3 minutes for the GA (t =14, P < 0.05, df=59). Mean postoperative pain scores was 2 ± 0.6 for caudal, 5 ±1 for the GA (t=4, p < 0.05, df=9). Time to first analgesic requirement was 170 ± 19 minutes, 39± 4 minutes for caudal and GA groups respectively (t=37, p < 0.05, df=59). Postoperatively 60% and 0% of patients in GA and caudal groups required opioid analgesic respectively.

Conclusion: Children who had herniotomy under caudal block with 0.5ml/kg of 0.25% plain bupivacaine had good analgesia with minimal complications. Caudal block in children is easy to perform and it's suitable for most day case infraumbilical surgeries.

Keywords: *Caudal block, general anaesthesia, herniotomy, children*

Résumé

Introduction : Le bloc caudal est un cas de procédure d'anesthésie fréquemment réalisée chez les enfants pour la plupart des chirurgies sous-ombilicale dans le monde entier, car il fournit une bonne analgésie pendant la période péri opératoire. Au Nigeria, il ya peu de données sur le bloc caudal d'où la justification de cette étude.

Méthodologie : Cette étude a comparé les effets analgésiques périopératoires et le profil de sécurité du bloc caudal en utilisant 0,5 ml/kg de poids corporel de bupivacaïne 0,25% brut avec l' anesthésie générale légère(AG) contre l'inhalation GA seul chez 60 enfants âgés de 2-10 ans qui avaient l' herniotomie utilisant l'échelle de douleur comportementale pour évaluer la douleur.

Résultats : Les résultats ont montré une durée moyenne de la chirurgie caudale de 17 ± 2 minutes (déviation standard (SD), 51 ± 6 minutes pour GA (t = 60, p< 0,05, df = 59). La durée moyenne de rétablissement Caudal postopératoire était de 6 ± 2 minutes, 14 ± 3 minutes pour le GA (t = 14, P< 0,05, df = 59). Les scores de douleur postopératoire étaient de 2 ± 0,6 pour caudale, 5 ± 1 pour le GA (t = 4, p< 0,05, df = 9). Impression de la première demande d'analgésique était de 170 ± 19 minutes, 39 ± 4 minutes pour les groupes caudale et GA respectivement (t = 37, p<0,05, df = 59). Après l'opération 60% et 0% des groupes de patients GA et caudal avaient besoin des opioïdes analgésiques respectivement. Les enfants qui avaient herniotomie sous anesthésie caudale avec 0.5ml/kg de bupivacaïne 0,25% brut avaient une bonne analgésie avec un minimum de complications.

Conclusion : Le bloc caudal chez les enfants est facile à réaliser et il est adapté à la plupart des cas quotidien de chirurgie sous-ombilicale.

Introduction

Since the first description of caudal block by Campbell in 1933 for paediatric urological interventions, it has evolved to become the most popular regional anaesthetic technique used in children for most infraumbilical surgeries [3]. It accounts for over 70% of elective paediatric procedures in Northern America [1]. In Nigeria there is paucity of literature on paediatric ambulatory surgical practice, despite the large number of paediatric patients whose surgical procedure could be done on day-case basis, under caudal block with proper patient and case selection.

Caudal analgesia is produced by injecting local anaesthetics into the caudal space to block the sacral and lumbar nerve roots. The caudal space is

Correspondence: Dr. Akinyemi, O. Akinola, Department of Anaesthesia, College of Medicine, University of Ibadan, PMB 5116, Ibadan, Nigeria. E-mail: oluakinakinyemi@yahoo.com

an extension of the epidural space in the sacral region. Anatomically, this space is located by identifying the tip of an equilateral triangle formed by the two posterior superior iliac spines. Caudal block is useful as a supplement to light general anaesthesia and for provision of analgesia in the perioperative period in children. A single shot injection can be given for procedures of short duration and continuous caudal block can be achieved by inserting a catheter into the caudal space for long procedures.

Instituting caudal block in an awake child is challenging due to lack of cooperation during the procedure, hence the child is usually first put to sleep [1] using a volatile anaesthetic agent by face mask. A good caudal block provides good analgesia throughout the duration of surgery and the postoperative period. The choice of local anaesthetic for the caudal block is quite varied but plain bupivacaine is commonly used though lidocaine, ropivacaine, levobupivacaine have been used [2]. For prolonged surgical procedures requiring extended periods of analgesia other adjuvants like opioids, clonidine, s-ketamine and neostigmine can be added to the local anaesthetics [4-6]. Opioids prolong analgesia in infants and children but with attendant risks of respiratory depression and side effects like nausea and vomiting, urinary retention and itching. Recent developments in paediatric caudal block involve the prolongation of caudal blocks with addition of adjuvants, use of safer local anaesthetic and inhalational agents and ultrasound guidance.

When caudal block fails, analgesic agents like paracetamol, nonsteroidal antiinflammatory drugs and opioids are required to treat acute postoperative pain. An effective caudal block encourages day case surgery, prevents the need for other analgesics and their attendant side effects like bleeding, postoperative nausea and vomiting (PONV) and respiratory depression. Pain management in children is a major challenge in that pain assessment is difficult in them as they do not have the cognitive and verbal skills necessary to report and describe pain. Many pain assessment tools exist for children of different age groups in order to confirm the presence of pain, assess its severity, prescribe and evaluate the efficacy of analgesics. Pain assessment tools are broadly divided into self and objective assessment tools with the former been the recommended method of pain assessment in adults and grown up children. Since children above 6 years can communicate to some extent a self assessment tool has been found to be an excellent form of pain measurement for this age [8]. The visual analogue scale (VAS) is a good example of self pain assessment and it is the gold standard pain tool for children of this age [8]. Objective pain assessment involves observing the child's behaviour by a third party. This has two phases: the first phase consists of expression of behavioural distress combined with psychological and physiological stress to pain. The second phase consists of a gradual reduction in the child's activity like moving, playing, sleeping, talking and eating as intensity of pain increases.

The Poker Chip scale and the revised face pain scale (FPS-R) are examples of the Objective pain tools that are useful for children aged between 4- 6 years. The self-assessment tools like VAS alone may not be adequate in children aged between 4 and 6 years and should be used in conjunction with other objective pain scales [7 - 9].

The aim of this study was to evaluate the perioperative analgesic effects and complications of caudal block versus GA in children who had herniotomy on day case basis.

Materials and methods

After ethical approval from the University of Ibadan / University College Hospital, Ibadan ethical review board, informed written consent was obtained from the parents of 60 healthy children, ASA 1, aged 2 - 10 years that presented for herniotomy at the University College Hospital, Ibadan. Nigeria. Exclusion criteria included patients with local infection in the caudal region, bleeding diathesis, aspirin ingestion during the previous week, preexisting neurological or obvious spinal diseases and congenital anomaly of the lower back. The patients were randomized into caudal and general anaesthesia (GA) groups using the Microsoft excel randomization sequence. The caudal group had their surgery done under caudal block following sedation with halothane and oxygen, while the GA group had the procedure done under general anaesthesia using halothane and face mask.

Anaesthesia was induced in all the children with halothane and oxygen via a paediatric breathing system and face mask. An intravenous (i.v) line was instituted and 4.3% dextrose in 0.18 saline was infused at the rate of 4ml/kg/hour for the first 10kg, 2 ml/kg/ hour for the next 10kg and 1 ml/kg/hour for the remaining kg body weight and 0.02mg/kg i.v atropine was administered. The concentration of halothane was gradually reduced from an initial dose of 2% to 1% as the patient attained surgical plane of anaesthesia. Following induction of anaesthesia patients in the caudal group were positioned in the left lateral position with some flexion applied to the spine. Under an aseptic condition a size 23 gauge

needle was inserted through the sacral hiatus into the caudal space. With the bevel facing cephalad about 2 cm of the needle was advanced into the caudal space and 0.5ml/kg of 0.25% plain bupivacaine was injected. Caudal anaesthesia was supplemented with light general anesthesia by reducing the concentration of halothane to 0.5% with the patient breathing spontaneously throughout the surgical procedure.

Following caudal block, two outcomes were defined: effective and ineffective. An effective caudal block was defined as a score of 3 on the caudal effective scoring scale [10] while an ineffective block was defined by a score of < 3 (Appendix 1). The caudal group did not receive any opioids, benzodiazepines or other drugs that affect central pain processing. The GA group had the concentration of halothane maintained between 1-1.5 % and the concentration was adjusted according to the patient's response to surgical stimulus. Prior to skin incision 0.5mg/kg i.v. pentazocine was administered. All the children had the pulse rate, respiratory rate and blood pressure recorded every 5 minutes throughout the procedure.

scale a score of 0= no pain, 1-3= mild pain, 4-6= moderate pain and 7-10 = severe pain. A child had pain relief whenever the pain score was > 3. The time to first analgesia (TFA) was defined as the time it took the patient to attain an objective pain score of >3.

Motor block was assessed after awakening of the patients using the Bromage scale. The procedure and purpose was explained to the parent and the older child. For younger or disabled child (who are unable to follow commands) one should try to elicit movement by tickling the toes, or gentle knee or hip flexion. The degree of motor block on both the left and right side were assessed. The rate of movement was rated according to the Bromage score i.e. 0= full flexion of knees and feet, 1= just able to move knees, 2 = able to move feet only; 3 = unable to move feet or knees).

The patients' vital signs were monitored closely for one hour before transfer to the general ward. On the ward, the pain score, pulse rate and respiratory rate were recorded every 30 minutes for 4 hours before discharge home on oral paracetamol at 20 mg/kg 8 hourly for 2 days. Children who had

Appendix 1: Caudal effectiveness score [10]

Score	0	1	2	3
Dose of halothane required during surgery to prevent movement	Impossible to reduce concentration of halothane < 1.5%	Halothane concentration increased to 1.5% after initial reduction	Halothane concentration decreased to 0.5% + HR or BP increase > 20% baseline value	Halothane concentration decreased to 0.5% + HR or BP increase < 20% baseline value

Caudal effectiveness score (0–3)
0= block not effective, 1-2= partially effective block, 3 = very effective block

Close to end of surgery, halothane was turned off, the pharynx was suctioned, and oxygen was administered for about 5 minutes. At the end of surgery the patients were transferred to the recovery room in left lateral position following recovery from anaesthesia. The duration of surgery was defined as the time of skin incision to the time the last stitch was made. The recovery time was defined as the time halothane was terminated to when patient responded to painful stimulus such as pinching of the skin around the armpit. On arrival in the recovery room, pain was assessed using the Behavioural Pain Rating Scale [8]. On this scale the five parameters observed in these children are: facial expression, restlessness, muscle tone, vocalization and consolability. Each of these variables was allotted scores of 0, 1, and 2 and the total score for the five variables ranged between 0 and 10 points. On this pain

i.v pentazocine due to a pain score of > 3 had their discharge delayed by 3 hours to ensure that the vital signs were stable. The parents kept a note of the number of times paracetamol was administered at home. All patients were reviewed 72 hours later in the clinic; a questionnaire was administered to the parents to document the total number of supplementary analgesics consumed by each child in a 24-hour period and presence of local or systemic complications were also sought.

Statistical analysis

The data from the caudal and GA groups was analysed using Excel statistical software. The mean, standard deviation, two-tailed t-tests of demographic and clinical data from the two groups were compared and analyzed. Intergroup differences among the variables were recorded and analyzed using a two-

way repeated-measure analysis of variance using group as the independent sample factor and time as the repeated-measurement factor. Test of significance between observed data from the two groups were calculated and $p < 0.05$ was considered statistically significant.

Results

Sixty (60) children aged 2-10 years who had herniotomy were enrolled into caudal and GA groups of 30 patients each. Their mean age ± standard deviation was 5.5 ± 2.1 years and 5.8 ± 2.2 years respectively (t=0.52, p<0.05, df=59). The demographic characteristics of the caudal and GA groups were comparable as there were no significant statistical differences in age, sex and weights (Table 1).

Three (3) patients had failed caudal block hence they were excluded from the caudal group and their trial numbers were reassigned to subsequent patients. The mean duration of surgery of 17±2 minutes for caudal and 51±6minutes for GA group was found to be statistically significant (t = 60, p< 0.05, df=59).

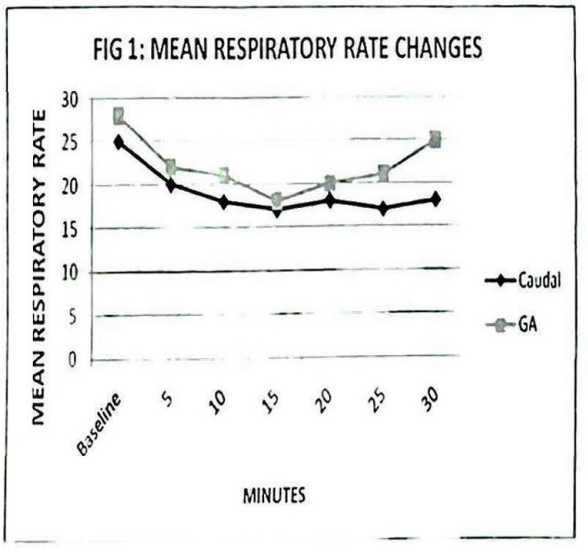
The mean recovery time postoperatively was 6±2 minutes for caudal and 14±3 for GA. This was statistically significant (t =14.4, p< 0.05, df= 59) (Table 1).

The mean pain score in the recovery room was statistically significant with a value of 2 ± 0.6 for caudal and 5±1 for GA (t= 4.26, p < 0.05, df= 9) (Fig. 4).

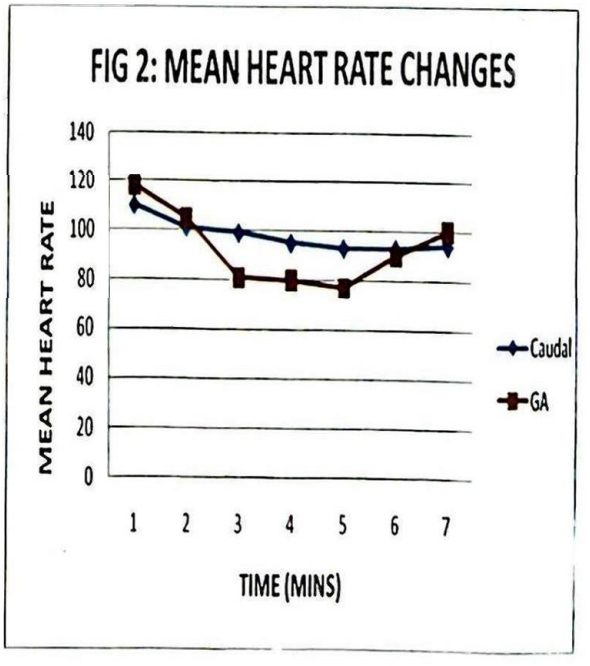
Table 1: Demographic data

	Caudal Group	GA Group
Total no of patients	30	30
Age range (years)	2-10	2-10
Mean age (±SD) years	5.5± 2.1	5.8 ± 2.2
Sex (male: female)	28 : 2	27:3
Mean duration of surgery (minutes)	17± 2	51± 6
Mean recovery time (minutes)	6± 2	14±3
Mean pain score on arrival in recovery room (±SD)	2± 0.6	5±1
Time to first Analgesia (TFA) ± SD (minutes)	170 ± 19	39± 4
Postoperative analgesic	PCM	Opioid
Opioid requirement by patients (%)	0	60
Perioperative complications	-	PONVx1, laryngeal spasm x2

The baseline respiratory rate (RR) was similar in the two groups but dropped slightly with increasing concentration of halothane. The RR was more stable in the caudal than the GA group throughout the period of surgery (fig.1).



The baseline mean heart rate (HR) changes were similar in both groups. There was not much fluctuations from the baseline HR in the caudal group during surgery. But the HR dropped by about 30% in the GA group 10 minutes into surgery as anaesthesia was deepened with halothane. (fig. 2).



The baseline mean arterial blood pressure (MAP) was comparable in both groups. The MAP dipped by about 5% midway into the surgery in both groups (Fig.3). Complications observed in the two groups were: failed caudal block in 3 patients (10%). In the GA group, 1 (3.3%) patient had PONV, 1 (3.3%) patient had laryngeal spasm (Table 1).

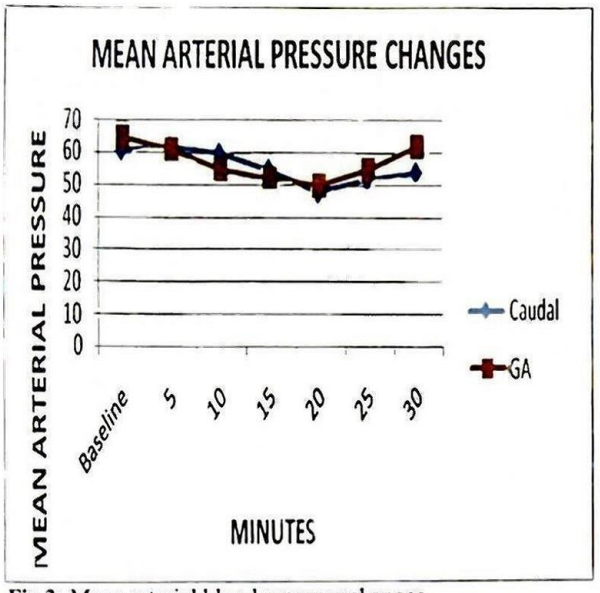


Fig.3: Mean arterial blood pressure changes

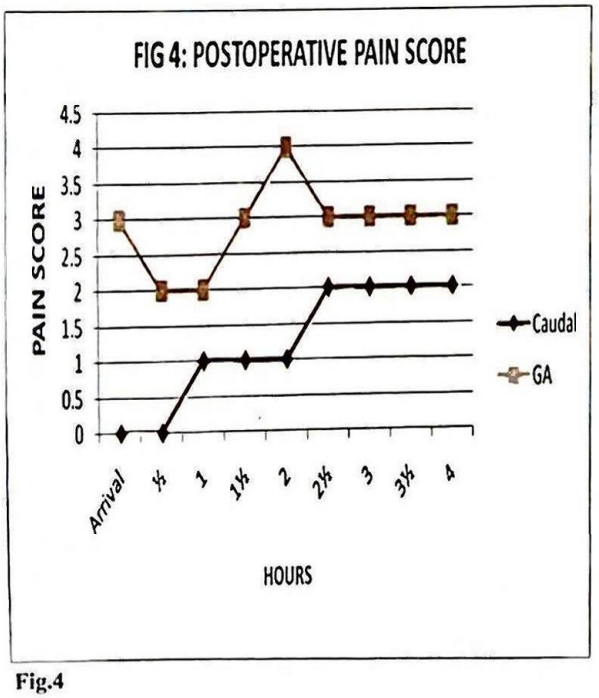


Fig.4

Discussion

Caudal block in paediatric anaesthetic practice is on the increase in most centres as it is a preferred method to relieve postoperative pain in children of all age groups undergoing sub-diaphragmatic surgeries. In our centre the common paediatric surgical procedures that are amenable to caudal block are herniotomy, herniorrhaphy, hydrocoelectomy, orchidopexy, circumcision, orthopaedic interventions on the lower limb, anorectal procedures and other types of lower abdominal surgeries.

All the children that we studied were put to sleep by breathing halothane and oxygen before the caudal was instituted. However care should be taken when anaesthetizing infants born preterm and those operated before 46 weeks post-conceptual age as they are prone to frequent apnoeic attacks under general anaesthesia, hence awake caudal block is recommended in them [4]. This age group was not included in our patient selection as we studied children between the ages of 2-10 years.

Following induction of anaesthesia and i.v canulation, all children had atropine 0.02mg/kg i.v to minimize or prevent excessive salivation and unwanted vagal effect on the cardiovascular system. Armitage described different dosage regimen for caudal block depending on the desired height of block. Using 0.25% bupivacaine, the doses are 0.5 ml/kg for sacrolumbar block, 1 ml/kg for upper abdominal block, and 1.2 ml/kg for mid-thoracic block [10]. Since all the children had herniotomy, a sacrolumbar block was sufficient for surgery, hence we administered a dose of 0.5mls/kg of 0.25% plain bupivacaine.

The technique of needle insertion is crucial to the success of caudal block. After inhalational induction the children were positioned in the lateral position, which was favoured by most authors [10-11]. The 23G needle was inserted to a depth of 2cm with the needle directed at an angle of 20 degrees to the skin to prevent puncture of the sacral bone and potential intra-osseous injection that could lead to a failed caudal block [12, 13]. Failed caudal block could be reduced by techniques like Swoosh test, ultrasound and nerve stimulation techniques [14, 15].

Effective and ineffective caudal outcomes were defined by the caudal effectiveness score. The hallmark of an effective caudal block was adequate analgesia during the surgical procedure. The children that had a score of less than 3 had their caudal block either supplemented with pentazocine or the dose of halothane was increased to 1-1.5%.

Demographically 60 children were randomly distributed into caudal and GA groups of 30 children each. The age range, mean age and sex distribution in the two groups were comparable and we found no significant statistical differences between the two groups. The mean duration of surgery between the caudal and GA groups of 17 ± 2 minutes and 51± 6 minutes respectively was statistically significant. The caudal group had a shorter duration of surgery because there were periods of disruption of surgery in the GA group when the patient lightened up and anaesthesia had to be deepened before surgery could continue.

Recovery after surgery was not immediate in both groups due to the residual effect of general anaesthetic agent administered. A mean recovery time of 6 ± 2 minutes obtained for the caudal group and 14 ± 3 minutes for GA group were statistically significant. This difference was due to the residual effect of the inhalational anaesthetic agent in the patients postoperatively which was higher in the GA group. Most authors were all in consensus that regional block is safer, reliable and ethical in an anaesthetized child hence majority of the children will definitely need sedation and/or general anaesthesia during regional anaesthetic techniques [6]. An awake, constantly crying and excited child would definitely be less suitable for regional techniques. Sinha [14] obtained a significantly prolonged recovery time in a randomized controlled study that involved 150 premedicated children 2- 8years that had caudal block versus general anaesthesia with sevoflurane. In that study the GA group that had sevoflurane had a more prolonged recovery time than those who had caudal block with light GA.

The caudal group had better pain control with a lower mean pain score of 2 ± 0.6 than the GA group with 5 ± 1 (Table 1). This difference was found to be statistically significant. The time to first analgesia postoperatively was about 4 times prolonged in the caudal group (170±19 minutes) compared to the GA group (39± 4minutes). This was statistically significant with a p value < 0.05. The caudal group was pain free for ~ 3 hours postoperatively than the GA group. Hannallah et al [15] reported a mean analgesic duration of 219 min (3.6h), Shobha et al reported an analgesic effect of about 12h after caudal block. [16]. Postoperatively the caudal group required a mild analgesic like paracetamol while the GA group required an opioid, pentazocine for relieve of pain.

The behavioural objective pain scale [7, 8] that was utilized in this study was found useful considering the age group of 2-10 years of the children studied. It was developed in 1996 as a simplified hybrid between two well-known behavioral pain scales i.e the 'Princess Margaret Hospital Pain Assessment' tool and the 'Children's Hospital of Eastern Ontario Pain Scale' (CHEOPS) [8].

Though the perioperative analgesic benefits of caudal block following infraumbilical surgeries in children are well recognized, some complications have been reported. These complications include dural puncture, intravascular injection, difficult injection of anesthetic solution, rectal penetration, drug overdose and side effect of the additive [9]. The survey by Giaufrè [9] reported a complication rate of 0.07% for caudal block. The complications found by Hillman [17] *et al* using plain bupivacaine for caudal anesthesia were emesis 10.7%, flushing 32.1% and pruritus 3.6%. In our study the complication rate was 0% for the caudal group and 10% for the GA group. In the GA group 3.3% had PONV and 6.7% had laryngeal spasm.

The effect of caudal block and general anaesthesia on respiration was shown on figure 1. Most authors observe that respiratory depression was not a common finding following caudal block and light general anaesthesia. However Brenner et al [11] in their study administered propofol infusion to 512 infants, preterms and postconceptional 46 week old newborns that had subumbilical surgery. They observed that 3.5% of their subjects had severe intraoperative apnoea at the beginning and at the end of the procedure. Hence they recommended that caudal block in sedated, spontaneously breathing patients might be a safe alternative for this age group than general anaesthesia.

The haemodynamic effects of caudal anaesthesia as shown on figures 2 & 3 showed that there was no statistical haemodynamic changes between the study groups. Significant changes in blood pressure are uncommon in pediatric patients after the proper administration of caudal block in otherwise healthy pediatric patients [17]. The occurrence of hypotension following caudal block should prompt anesthesiologists to immediately rule out a total spinal and/or intravascular injection leading to local anesthetic toxicity.

Conclusion

Caudal block is a simple, safe and effective method of providing effective perioperative analgesia in children. A well-founded knowledge of the specific anatomical, physiological and pharmacokinetic characteristics of paediatric patients is indispensable to safely institute paediatric regional block. Guidelines for safe preparation of children, parents, sedation and

techniques of caudal block are available and should be followed as these are crucial to the success of the procedure. This study revealed that caudal anaesthesia using 0.25% plain bupivacaine provided good perioperative analgesia in children following herniotomy than in those that had the procedure done under general anaesthesia.

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