Mediscope The Journal of GMC

ORIGINAL ARTICLE

Spinal anaesthesia in children under sedation

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Abstract

Spinal anaesthesia in children evolved more than hundred years ago and gaining considerable popularity worldwide. In our setups in Bangladesh, this technique has not gained popularity yet but over the past few years this technique has been practiced in some centers. The objective of the present study was to observe the efficacy and safety of spinal anaesthesia under sedation in children scheduled for infra-umbilical surgical procedures. In this study, 67 children of age ranging from 2 to 10 years of either sex, with American Society of Anaesthesioloists physical status I and II, undergoing infra-umbilical surgeries were included. Spinal anaesthesia was administered with Quincke 27 gauge needles between L4–L5 or L5-S1 interspace in the lateral position under sedation with ketamine and midazolam. Heart rate, mean arterial blood pressure and oxygen saturation (SpO_2) were monitored throughout perioperative period. Complications of sedation and spinal anaesthesia were recorded and managed accordingly. Among 67 children, male and female were 62 (92.5%) and 5(7.5%), respectively. The mean (SD) age, body weight, American Society of Anaesthesiologists physical status I and II was 5.2 (2.1) years, 15.5 (4.8) kg, 60 (89.6%) and 7 (10.5%), respectively. Successful spinal anaesthesia was done in all cases. The incidences of side effects of sedation were transient apnoea 1 (1.5%), desaturation (SpO_2<93%) 3 (4.5%), stridor 1 (1.5%), laryngospasm 1 (1.5%) and agitation 4 (6.0%). Side effects were transient, self limiting and managed conservatively. Complications of spinal anaesthesia were hypotension 2 (3.0%), bradycardia 1 (1.5%), shivering 1 (1.5%), nausea and vomiting 1 (1.5%) and backache 1 (1.5%). The complications were minor and managed accordingly. There were no serious adverse events reported in any child. The mean (SD) operation time and recovery time from anaesthesia was 49.2 (8.4) minutes and 91.2 (9.2) minutes, respectively. Spinal anaesthesia under sedation with ketamine and midazolam is safe and effective technique for paediatric infraumbilical surgery.

Key words: Children, spinal anaesthesia, sedation, ketamine, midazolam.

Introduction

The first report on pediatric spinal anesthesia was reported by Bier in 1899, when the technique was performed with cocaine in an 11 year old boy for ischial abscess drainage.[1] In 1900, Bainbridge reported a case of an infant of three months for the repair of a strangulated hernia using spinal anesthesia.[2] In 1909, a detailed procedure of pediatric spinal anesthesia was published by Tyrell-Gray reporting experience from 300 pediatric surgical procedures.[3] By middle of the century, considerable improvement in techniques of general anaesthesia (introduc-

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tion of muscle relaxants and safe intravenous induction agents) was achieved; however, lack of expertise for spinal anaesthesia (fear of adverse effects, lack of parent and patient cooperation) possibly prevented widespread use of spinal anaesthesia in children. In the last decade, it started being advocated by many centers due to increasing knowledge on pharmacology, safety information and availability of specialized equipment for regional anaesthetic techniques and monitoring in children.

Children usually cannot tolerate the administration of spinal anaesthesia unless they are deeply sedated or on general anesthesia. Most children require additional sedation (ketamine, midazolam, thiopentone, propofol, halothane, sevoflurane, nitrous oxide, etc) for performing spinal anaesthesia and surgical procedure.[4,5]

Ketamine has been widely used as sedo-analgesic agent worldwide since its introduction in 1970 and its safety profile has proven excellent in various settings.[6-12] Ketamine produces a unique state of cortical dissociation that allows painful procedures to be done more consistently and effectively than with other procedural sedation and analgesia drugs. This state of dissociative sedation is characterized by profound analgesia, sedation, amnesia, and immobilization, and can be rapidly and reliably produced with intravenous or intramuscular administration.[13,14]

We therefore designed a case series study to analyze the feasibility of spinal anaesthesia for infraumbilical surgery in children under procedural sedation with ketamine and midazolam.

Materials and method

This prospective case series analysis was done in Prime Medical College and Hospital, Rangpur within the period of 12 months from January 2015 to December 2015. Study was approved by the Research Ethics Committee of the Institution. The study was conducted on total 67 patients.

Inclusion criteria were: age- 2 years to 10 years, gender- both male and female, American Society of Anaesthesiologists (ASA) physical status I and II, patients scheduled for elective surgery below umbilicus, parents gave consent for spinal anesthesia, and expected duration of surgery around 60 to 90 minutes.

Exclusion criteria were: parental refusal, coagulation abnormalities, local infection at the spinal puncture site, neurological abnormalities such as spina bifida, increased intracranial pressure, uncorrected hypovolemia, and allergy or hypersensitivity to local anesthetic drugs.

All children were fasted 6 hours for solid food, 4 hours for liquid food and 2 hours for clear fluids before operation. An intravenous line was established with 20 or 22 gauge cannula in the operation theatre. A loading dose of injection ketamine 1 mg/kg body weight was given intravenously over 60 seconds. Injection midazolam 0.1 mg/kg body weight was given intravenously to prevent agitation and nightmares. The maintenance of spontaneous respiration was verified and oxygen was supplemented via facemask. Baseline vital parameter; pulse oximetry (SpO_2), heart rate, ECG, mean arterial blood pressure (MAP) were recorded. Patients were positioned in lateral position without flexing neck, taking care of airway. The lumbo-sacral region was scrubbed with antiseptic solution of povidone iodine solution and then draped with sterile towels. Lumber puncture was performed with 27 gauge Quincke spinal needle at L4-L5 or L5-S1 interspace. After free reflux of cerebrospinal fluid (CSF) 0.5% bupivacaine (hyperbaric) 0.3 mg/kg body weight was injected slowly over 30 seconds into the subarachnoid space. The spinal needle was then slowly withdrawn. Punctured area was covered with sterile gauze and then patient was put in the supine position. The efficacy of the sensory block was assessed with response to pin prick and motor block in the flaccid paralysis of lower extremities (unable to move hip, knees and foot).

After establishment of the block the required surgery was allowed to perform. The patient's vital parameters; heart rate, respiratory rate, non invasive blood pressure particularly MAP, SpO_2 and ECG were monitored peroperatively at 5 minutes interval through out the operation. Assessment of level of sedation was monitored by using Ramsay Sedation Scale (RSS).[15] Additional incremental doses of ketamine were administered slowly in aliquots till RSS reached 5. For maintenance and replacement of fluid, 5% dextrose in 0.45% normal saline was administered intravenously. Room temperature was maintained at 24-26°C. Preparation for general anaesthesia, airway equipments and emergency resuscitation drugs were ready in operation theater to combat any adverse event. Immediate complications of spinal anesthesia were observed, recorded and managed accordingly. The operational definitions were: hypotension- decrease in MAP more than 20% from baseline, bradycardia- decrease in heart rate less than 15% from baseline, desaturation- SpO_2 below 93%, high spinal- defined as motor block of the upper limbs, no response to hand pinch.

Side effects of ketamine sedation like transient apnoea (cessation of respiration more than 15 seconds), SpO_2 less than 93%, laryngospasm, stridor and agitation were observed, recorded and managed.

After completion of surgery, patients were transferred to recovery room and their vital signs were monitored, till the block regressed. Recovery status was assessed by Aldrete Recovery Score (ARS).[16] Patients were considered ready to be discharged from recovery room when they had stable vital signs, oriented, had no intractable nausea or vomiting, had minimum pain, and ARS is persistently at least 8 or more than 8. Recovery time was calculated as the time from the last dose of medication given until discharge criteria were met. The children were then transferred to ward, where fluid maintenance continued until oral food allowed, children were allowed to feed as soon as possible, provided there were no surgical restrictions. Patients were followed postoperatively in the ward to evaluate late complication of spinal anaesthesia like postdural puncture headache (PDPH), transient neurological symptoms, meningitis, meningism, backache and urinaryretention. Results were reported using descriptive statistics (Microsoft Excel; Microsoft Corporation) and expressed as mean (SD) or percentage (%) where appropriate.

Results

Patient's characteristics are presented in Table 1. Among 67 children, male and female were 62 (92.5%) and 5(7.5%), respectively. The mean (SD) age, body weight, ASA physical status I and II was 5.2 (2.1) years, 15.5 (4.8) kg, 60 (89.6%) and 7 (10.5%), respectively. Different types of surgical procedures are presented in Table 2. Types of surgery were inguinal hernia repair 28 (41.8%), circumcision 17 (25.4%), appendicectomy 8 (11.9%), rectal polypectomy 6 (9.0%), hypospadius repair 5 (7.4%) and orchidopexy 3 (4.5%). Haemodynamic parameters of the children were shown in Table 3. Haemodynamic parameters of the patients were almost stable in all cases. The incidences of side effects of sedation were shown in Table 4. The incidences of side effects of sedation were: transient apnoea 1 (1.5%), desaturation (SpO_2<93%) 3 (4.5%), stridor 1 (1.5%), laryngospasm 1 (1.5%) and agitation 4 (6.0%). Side effects were transient, self limiting and managed conservatively. Complications of spinal anaesthesia were shown in Table 5. The complications of spinal anaesthesia were hypotension 2 (3.0%), bradycardia 1 (1.5%), shivering 1 (1.5%), nausea and vomiting 1 (1.5%) and backache 1 (1.5%). The complications were minor and managed accordingly. There were no serious adverse events reported in any child. The duration of operation time and recovery time is shown in Table 6. The mean (SD) operation time and recovery time from anaesthesia was 49.2 (8.4) minutes and 91.2 (9.2) minutes, respectively.

Table 1. Characteristics of the patients, n = 67

Characteristics	Number	%
Gender		
Male	62	92.5
Female	5	7.5
American Society of Anaesthesiologists physical status		
I	60	89.6
II	7	10.5
Age in years, mean (SD)	5.2 (2.1)	
Body weight in kg, mean (SD)	15.5 (4.8)	

Table 2. Types of surgery, n = 67

Surgery	Number	%
Inguinal hernia repair	28	41.8
Circumcisions	17	25.4
Appendicectomy	8	11.9
Rectal polypectomy	6	9.0
Hypospadias repair	5	7.4
Orchidopexy	3	4.5

Table 3. Haemodynamic changes in patients (n = 67)

Reading time	Mean arterial pressure Mean (SD)	Heart rate Mean (SD)
Baseline reading	64.9 (4.3)	96.7 (5.2)
Immediately after spinal anaesthesia	63.5 (5.2)	98.3 (5.8)
10 minutes after spinal anaesthesia	62.4 (4.1)	94.5 (4.2)
20 minutes after spinal anaesthesia	61.8 (4.0)	93.6 (3.4)
30 minutes after spinal anaesthesia	61.6 (3.7)	92.4 (3.0)
40 minutes after spinal anaesthesia	62.1 (3.5)	91.6 (2.8)
50 minutes after spinal anaesthesia	61.1 (3.5)	91.1 (2.7)

Table 4. Side effects of sedation in patients (n = 67)

Side effects	Number	%
Transient apnoea	1	1.5
Desaturation	3	4.5
Stridor	1	1.5
Laryngospasm	1	1.5
Agitation	4	6.0

Table 5. Incidences of complications of spinal anaesthesia in patients (n = 67)

Type of complications	Number	%
Hypotension	2	3.0
Bradycardia	1	1.5
Shivering	1	1.5
Nausea, vomiting and retching	1	1.5
High spinal anaesthesia	-	-
PDPH	-	-
Backache	1	1.5
Meningism	-	-
Transient neurological symptoms	-	-
Meningitis	-	-
Urinary retention	-	-

Table 6. Duration of operation time and recovery time in patients (n = 67)

	Values mean (SD)
Duration of surgical procedure, minutes	49.2 (8.4)
Recovery time, minutes	91.2 (9.2)

Discussion

There are important anatomic differences between children and adults, which are related to the child's development stage which should be considered at performing spinal anesthesia in children. Neonates spinal cord extends at the level of the third lumbar vertebra and, at the end of the first year of life reaches the location seen in adults, at the first lumbar vertebra.[17,18] Lumbar puncture in this age group must be performed below the 4th or 5th lumbar vertebrae (L4-L5 or L5-S1 interspace), for additional safety due to the risk of reaching the spinal cord with the needle.[19-21] In this study spinal block was performed either L4-L5 or L5-S1 interspace.

Cardiovascular changes related to the spinal anaesthesia are less common in children than in adults. In children under 5 years of age, minimal changes in heart rate and blood pressure have been reported.[22,23] In older patients (>8 years old), the sympathetic block can induce bradycardia or hypotension. In this study patients were haemodynamically stable in almost cases. Hemodynamic suppression following spinal anaesthesia is absent in children due to a smaller peripheral blood pool, immature sympathetic autonomic system, and compensatory reduction in vagal efferent activity.[24] Hence, preloading before spinal anaesthesia is not a routine in children.[25]

Performing spinal puncture in a struggling, agitated child may injure delicate neurovascular structures and should be avoided. Most children require additional sedation (ketamine, midazolam, thiopentone, propofol, halothane, sevoflurane or nitrous oxide).[26,27] In this study, sedation regimen with ketamine and midazolam provided optimal conditions for spinal anaesthesia represented success rate 100%. General anaesthesia regarded to be safe, but the risk of post operative apnoea and hypoxaemia is not negligible in infants who are born preterm and operated upon before post conceptual age of 46 weeks.[28,29] The rate of apnoea in this study was very low, short apnoea after induction of sedation required short time bag-valve-mask ventilation until spontaneous respiration regained. The specific dangers of airway compromise are suggested to be less with ketamine.[30,31] Incidences of desaturation (SpO_2<93%) found in 4.5% children, managed with managed with supplemental oxygen, 3% children, who suffered from laryngospasm and stridor, could be treated conservatively. The fewer incidences of airway problems and desaturation supported the safety of ketamine administration regarding airway and hypoxia.[9,12,32] Though midazolam was given, few incidences of agitation were observed in this study and those were transient and minor inconvenience.

We assessed efficacy of the sensory block with response to pin prick and motor block by flaccid paralysis in the lower extremities. In awaken children the extent of the sensory block can be checked by pin prick or skin pinch and that of the motor block by Bromage scale.[33] This may, however, be difficult to check in a deeply sedated child, inability to move the blocked extremity after emergence is a good evidence of successful block.

The complications related to spinal anaesthesia are usually either due to the needle used to perform the procedure (backache, headache, nerve or vascular injury, infection, etc) or the drugs injected (high or total spinal, drug toxicity). Complications in children are lower than in adults.[34] However, problems associated with regional anaesthesia in children may be underestimated.[35] Early complications of spinal anaesthesia like hypotension 3%, bradycardia 1.5%, desaturation 1.5%, shivering 1.5% and nausea and vomiting in 1.5% were observed in this study. Those were mild and treated accordingly with minimum interventions. In this study, we found late complications of spinal anaesthesia like backache 1.5%, no incidences of PDPH and transient neurological symptoms. PDPH is rare in paediatric patients and some authors have even challenged its existence.[36] Backache is a common complaint, found in 5-10% patients but its causal relationship has not been established.[37] Transient neurological symptoms reported 3-4% and described as new onset of pain and peraesthesia originating in gluteal region and radiating to lower limbs.[37] In most cases, symptoms are mild. A one year study of 24409 regional blocks in children by the French-Language Society of Pediatric Anesthesiologists, the largest known study on complications, revealed a complication rate of 1.5 per 1000 in the 60% of children receiving central neuraxial blocks.[38] Association des Anesthésistes Réanimateurs Pédiatriques d'Expression Française's prospective study in preterm to adolescent patients reported only one complication (intravenous injection) after 506 spinal anaesthesia.[34]

The mean (SD) recovery time from anaesthesia was 91.2 (9.2) minutes. Spinal anaesthesia under sedation with ketamine is safe and effective technique for paediatric infraumbilical surgery but it delays recovery when used with short acting benzodiazepines like midazolam.

A limitation of this study was that we could not measure end tidal carbon dioxide ($EtCO_2$). For measurement of $EtCO_2$, special sensor containing facemask is required.

Conclusion

Spinal anaesthesia under ketamine sedation is safe technique in children in the hands of an experienced anesthetist with proper patient selection, drugs, and dosages. Spinal anaesthesia might be an effective choice in children undergoing elective surgeries below umbilicus, rather than just as an alternative to general anaesthesia.

References

1. Bier A. Experiment regarding the cocainization of the spinal cord. Zentralbl Chir 1899;51:361-9.
2. Bainbridge WS. A report of twelve operations on infants and young children during spinal anesthesia. Arch Pediatr 1901;18:570-4.
3. Tyrell-Gray H. A study of spinal anaesthesia in children and infants. Lancet 1909;2:913-7.
4. Kokki H, Heikkinen M, Ahonen R. Recovery after paediatric day case herniotomy performed under spinal anaesthesia. Pediatr Anesth 2000;10:413-7.
5. Singh R, Batra YK, Bharti N, Panda NB. Comparison of propofol versus propofol-ketamine combination for sedation during spinal anesthesia in children: randomized clinical trial of efficacy and safety. Paediatr Anaesth 2010;20:439-44.
6. Green SM, Krauss B. Clinical practice guideline for emergency department ketamine dissociative sedation in children. Ann Emerg Med 2004;44:460-71.
7. Pena BMG, Krauss B. Adverse events of procedural sedation and analgesia in a pediatric emergency department. Ann Emerg Med 1999;34:483-90.
8. Pitetti RD, Singh S, Pierce MC. Safe and efficacious use of procedural sedation and analgesia by nonanesthesiologists in a pediatric emergency department. Arch Pediatr Adolesc Med 2003;157:1090-6.
9. Green SM, Rothrock SG, Lynch EL, et al. Intramuscular ketamine for pediatric sedation in the emergency department: safety profile with 1,022 cases. Ann Emerg Med 1998;31:688-97.
10. Green SM, Kuppermann N, Rothrock SG, Hummel CB, Ho M. Predictors of adverse events with ketamine sedation in children. Ann Emerg Med 2000;35:35-42.
11. Green SM, Clem KJ, Rothrock SG. Ketamine safety profile in the developing world: survey of practitioners. Acad Emerg Med 1996;3:598-604.
12. Green SM, Rothrock SG, Harris T, Hopkins A, Garrett W, Sherwin T. Intravenous ketamine for pediatric sedation in the emergency department: safety profile With 156 cases. Acad Emerg Med 1998;5:971-6.
13. Green SM, Krauss B. The semantics of ketamine. Ann Emerg Med 2000;36:480-2.
14. Griffith RD, Jones C. Recovery from intensive care. Bri Med J 1999;319:427-9.
15. Egelhoff JC, Ball WS, Koch BL, Parks TD. Safety and efficacy of sedation in children using a structured sedation program. Am J Roentgenol 1997;168:1259-62.
16. Aldrete JA. The post anesthetic recovery score revisited. J Clin Anesth 1995;13:89-91.

17.Rice LJ. Regional Anesthesia and Analgesia. In: Motoyama EK, Davis PJ-Smith, eds. Anesthesia for Infants and Children. Mosby St Louis; 1996.
18.De Negri P, Barrometi F, Visconti C. Spinal anesthesia for pediatrics. Techniques in Regional Anesth and Pain Management 1998;2:188-93.
19.Geiduschek JM. Pediatrics. In: Brown DL, ed. Regional anaesthesia and analgesia.1st ed. Philadelphia: WB Saunders Company; 1996.
20.Rice LJ, Britton JT. Neonatal Spinal Anesthesia. Anesthesiol Clinic North Am 1992;10:129-44.
21.Williams RK, Abajian C. Spinal anesthesia in infants. Techniques in Regional Anesth and Pain Management 1999;3:170-176.
22.Dohi S, Naito H, Takahashi T. Age related changes in blood pressure and duration of motor block in spinal anesthesia. Anesthesiology 1979;50:319-23.
23.Oberlander TF, Berde CB, Lam KH, Rappaport LA, Saul JP. Infants tolerate spinal anesthesia with minimal overall autonomic changes: analysis of heart rate variability in former preterm infants undergoing hernia repair. Anesth Analg 1995;80:20-7.
24.Dohi S, Seino H. Spinal anesthesia in premature infants: dosage and effects of sympathectomy. Anesthesiology 1986; 65:559-61.
25.Mahe V, Ecoffey C. Spinal anesthesia with isobaric bupivacaine in infants. Anesthesiology 1988;68:601-3.
26.Williams RK, Adams DC, Aladjem EV, et al. The safety and efficacy of spinal anesthesia for surgery in infants: The Vermont Infant Spinal Registry. Anesth Analg 2006;102:67-71.
27.Singh R, Batra YK, Bharti N, Panda NB. Comparison of propofol versus propofol-ketamine combination for sedation during spinal anesthesia in children: randomized clinical trial of efficacy and safety. Paediatr Anaesth 2010;20:439-44.
28.Kurth CD, Spitzer AR, Broennle AM, Downes JJ. Postoperative apnea in preterm infants. Anesthesiology 1987; 66:483-8.
29.Liu LM, Cote CJ, Goudsouzian NG, et al. Life-threatening apnea in infants recovering from anesthesia. Anesthesiology 1983;59:506-10.
30.Drummond GB. Comparison of sedation with midazolam and ketamine: effects on airway muscle activity. Br J Anaesth 1996;76:663-7.
31.Petrack EM, Marx CM, Wright MS. Intramuscular ketamine is superior to meperidine, promethazine and chlorpromazine for paediatric emergency department sedation. Arch pediatr Adolesc Med 1996;150:676-81.
32.Green SM, Johnson NE. Ketamine sedation for pediatric procedures; Part 2, review and implications. Ann Emerg Med 1990;19:1033-46.
33.Bromage PR. A comparison of the hydrochloride and carbon dioxide salts of lidocaine and prilocaine in epidural analgesia. Acta Anaesthesiol Scand 1965;16:55-69.
34.Ecoffey C, Lacroix F, Giaufre E, Orliaguet G, Courrèges P; Association des Anesthésistes Réanimateurs Pédiatriques d'Expression Française (ADARPEF). Epidemilogy and morbidity of regional anesthesia in children: a follow-up one year prospective survey of the French-Language Society of Pediatric Anesthesiologists (ADARPEF). Paediatr Anaesth 2010;20:1061-9.
35.Lacroix F. Epidemiology and morbidity of regional anaesthesia in children. Curr Opin Anaesth 2008;21:502-6.
36.Kokki H, Hendolin H. Comparison of 25 G and 29 G Quincke spinal needles in paediatric day case surgery. A prospective randomized study of the puncture characteristics, success rate and postoperative complaints. Paediatr Anaesth 1996;6:115-9.
37.Kokki H. Spinal blocks. Paediatr Anaesth 2012;22:56-64.
38.Glaufre E, Dalens B, Gombert A. Epidemiology and morbidity of regional anesthesia in children: a one year prospective study of the French-Language Society of Pediatric Anesthesiologists. Anesth Analg 1996; 83:904-12.

Suggestion for citation of the above:

Maruf AA, Alam M, Ali MB, Nazrina S. Spinal anaesthesia in children under sedation. Mediscope 2017;4(1):18-24.