Revista Colombiana de Anestesiología
Colombian Journal of Anesthesiology

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Case report

Case report: Multimodal spinal anesthesia in a pediatric patient with a difficult airway☆

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ARTICLE INFO

Article history:
Received 31 August 2012
Accepted 19 March 2013
Available online 22 June 2013

Keywords:
Anesthesia
Clonidine
Airway
Child
Neuromuscular Blocking Agents

ABSTRACT

Introduction: Spinal anesthesia has been part of the pediatric anesthesia practice for more than 100 years. Its use has been increasing in recent years because of its effectiveness, efficiency and safety. We report a successful case in a patient with a difficult airway.
Objective: To report a case of spinal anesthesia and sedation with remifentanil, together with a review of the literature including alpha 2 agonists for locoregional procedures in pediatrics.
Methods: Search of relevant references in PubMed, MD consult and BIREME. The search resulted in 306 articles, and 23 considered relevant by the authors were finally selected.
Results: We present a case of a 1-year-old boy with an expected difficult airway because of the presence of a cavernous hemangioma of the lower lip, scheduled for surgical correction of bilateral club foot. Spinal anesthesia consisted of 0.5% hyperbaric carbonated bupivacaine plus 30 μg of clonidine (1.3 ml total), maintaining sedation-analgesia at 3–4/6 on the Ramsay scale with remifentanil 0.05–0.075 μg/kg/min, 50% oxygen with facial mask, and spontaneous ventilation, with no hemodynamic or respiratory adverse effects.
Conclusions: Spinal anesthesia is an option in cases of predicted difficult airway. Clonidine (alpha 2 agonist) prolongs blockade with no hemodynamic or respiratory complications. Remifentanil used for sedation in pediatric locoregional procedures is easy to titrate with predictable results.

☆ Please cite this article as: Diaz Herrera D, et al. Reporte de caso: anestesia espinal multimodal en paciente pediatrico con via aerea dificil. Rev Colomb Anestesiol. 2013. http://dx.doi.org/10.1016/j.rca.2013.05.001.
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Reporte de caso: anestesia espinal multimodal en paciente pediátrico con vía aérea difícil

Palabras clave:
Anestesia
Clonidina
Vía aérea
niño
Bloqueantes Neuromusculares

RESUMEN

Introducción: la anestesia espinal lleva más de 100 años en la práctica anestésica pediátrica. Actualmente viene aumentando su uso por ser eficaz, eficiente y segura. Se expone un caso exitoso en paciente con vía aérea difícil.

Objetivo: Reportar un caso de anestesia espinal y sedación con remifentanilo, haciendo la revisión de la literatura incluyendo fármacos alfa 2 agonistas, para procedimientos locorregionales pediátricos.

Métodos: búsqueda bibliográfica relevante en las bases bibliográficas PubMed, MD consult y BIREME. Inicialmente se obtienen 306 artículos, seleccionando 25 considerados relevantes por los autores.

Resultados: se presenta el caso de un niño de un año de edad, con vía aérea difícil predicha por un hemangioma cavernoso en labio inferior, programado para corrección quirúrgica de pie chapín bilateral. Se administra anestesia espinal con bupivacaína hiperbárica 0,5% carbonatada 5 mg y clonidina 30 g(1,3 ml total), manteniendo sedoanalgesia 3-4/6 de Ramsay con remifentanilo 0,05-0,075 g/kg/min, con oxígeno 50% por máscara facial y ventilación espontánea sin efectos adversos hemodinámicos o respiratorios.

Conclusiones: la anestesia espinal es una alternativa ante una vía aérea difícil predicha. La clonidina (alfa 2 agonista) prolonga la duración del bloqueo sin complicaciones hemodinámicas o respiratorias. El remifentanilo para sedación en los procedimientos locorregionales pediátricos es de fácil titulación, con resultados predecibles.

Methodology

Case review and topic review based on a search that included medical practice guidelines, meta-analysis, systematic reviews, clinical trials, case reports and review of the literature of the past 5 years, both in English and Spanish in the PubMed, MD consultation and BIREME databases. MESH terms used: spinal anesthesia, clonidine, remifentanil, sedation, pediatrics.

Of the initial 306 articles, 8 met the selection criteria. Results were obtained through reading, interpreting and analyzing each of the articles, some of which led to additional references, for a total of 23.

Case presentation

The case was a twelve-month-old male child 75 cm tall, weighing 10 kg and coming from the rural area of Huila with a congenital equinovarus foot (club foot) and lower-lip cavernous hemangioma, who was scheduled for surgical correction of the bilateral club foot. He had no significant personal or family history.

The physical examination revealed a difficult airway because of the presence of a tumor mass 2 cm high × 3 cm wide in the lower lip. Both feet were completely inverted, with the forefoot in adduction.

At the pre-anesthesia assessment, the anesthesiologist found an ASA 2/5 patient, with low surgical risk and a difficult airway because of a prominent mass in the lower lip. The anesthesia plan was designed to include spinal anesthesia plus sedation and analgesia with remifentanil and spontaneous ventilation through a facemask.

Table 1 – Ramsay scale.

Level	Description
Awake	
1	Anxious, agitated or uneasy
2	Cooperative, oriented and calm
3	Drowsy. Responds to normal verbal stimuli
Asleep	
4	Quick response to loud noises or to gentle tapping on the forehead
5	Lazy response to loud noises or to gentle tapping on the forehead
6	Absence of response to loud noises or to gentle tapping on the forehead

Modified from Ramsay et al. BMJ, 1974; 2: 656-659.

Upon admission the patient was given ketamine 10 mg *i.v.* plus midazolam 0.5 mg *i.v.*, achieving a sedation of 5/6 on the Ramsay scale (Table 1). Intraoperative basic monitoring was set up (cardioscope in DII, pulse oximetry, non-invasive blood pressure every 5 min, and capnography). The remifentanil infusion was started at a rate of 0.1 μg/kg/min following which the patient was placed on a right lateral decubitus fetal position. After asepsis and antisepsis, the L3–L4 intervertebral space was localized (Fig. 1), a lumbar puncture was performed using a number 22 hypodermic needle, the return of clear CSF is observed, and 1.3 ml of 0.5% hyperbaric carbonated bupivacaine 5 mg plus clonidine 30 μg were administered (Fig. 2). The dose of remifentanil was titrated between 0.05 and 0.075 μg/kg/min, with the goal of

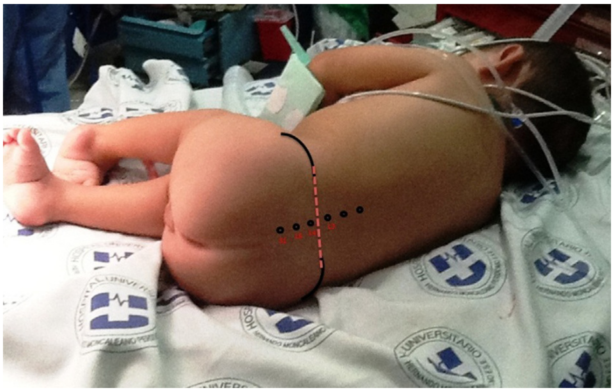

Fig. 1 – Location of the reference points. Source: authors.

Fig. 2 – Lumbar puncture. Source: authors.

maintaining a state of sedation and analgesia of 4/6 on the Ramsay scale, and spontaneous ventilation. Dexamethasone 1 mg, Ketorolac 2.5 mg, Ondansetron 1 mg and Cefazoline 500 mg were given intravenously before the surgical incision.

The surgical procedure lasted 4 h and a good anesthetic block was maintained throughout. The patient remained hemodynamically stable, with no bradycardia, hypotension, apnea or arterial desaturation. The patient received, overall, 180 cm^3 of crystalloids and had an estimated blood loss of 50 cm^3. There were no surgical or anesthetic complications. Remifentanil was interrupted at the end of the surgery.

The patient was transferred to the post-anesthetic care unit with a level of sedation of 2/6 on the Ramsay scale and no lower limb motor blockade. He remained in the PACU for 1 h with no evidence of requiring additional analgesia or management of nausea or vomiting. The patient was admitted and then discharged 24 h later, with recommendations and instructions for a follow-up visit to the orthopedics outpatient clinic in eight days.

Topic review

Spinal anesthesia in pediatrics

August Bier was the first to report in 1899 a case series of successful spinal blockade using subarachnoid cocaine in pediatric patients.[1] Later, locoregional anesthesia was used massively during the first decades of the 20th century in the pediatric population, driven by inaccuracy and lack of safety with the use of chloroform or ether-based general anesthesia. With new advances in the pharmacological knowledge of muscle relaxants, inhaled and intravenous anesthesia, and the development of new equipment and greater experience in the management of the airway and the use of mechanical ventilation, locoregional techniques in pediatrics were left by the sideway gradually.[2] Starting in the 1980s there was a reemergence of regional techniques in pediatrics because of the undeniable advantages demonstrated in the literature for the intra- and post-operative periods and for the management of chronic pain.[3]

Subarachnoid anesthesia is indicated in a large number of infraumbilical surgical procedures. There is a clear indication in neonates under 60 weeks of postconceptional age because of the high risk of respiratory complications and apnea during the post-operative period after general anesthesia, a risk which is greater when there have been episodes of apnea or a hematocrit of less than 30% during the pre-operative period. Experts recommend spinal anesthesia as an alternative in the following clinical situations:

1. Potentially difficult airway.[4–6]
2. Chronic respiratory diseases.
3. Malignant hyperthermia.
4. Congenital heart diseases, helping to minimize hemodynamic fluctuations.[7]
5. Epidermolysis bullosa, where airway manipulation must be minimized.[8,9]
6. Sleep disorders.

In order to perform the technique, the anesthesiologist must be very familiar with the spinal anatomy and its differences with the adult spine. At birth, the spinal cord ends at the level of L4–L5, with cephalad advancement during the first year of life, until if finally comes to rest between lumbar segments L1 and L2. Meninges are localized at the level of the sacral vertebrae S2–S3, remaining at this level throughout growth. The distance between the skin and the dura mater in the neonatal lumbar spine is often 1–1.5 cm; an approximate calculation may be done using the formula of $(\text{weight} + 10) \times 0.8$ or also 1 mm per kg.[10]

CSF volume is a determining factor for local anesthetic diffusion in the neural axis. The volume of CSF in neonates is 4 ml/kg (twice the adult volume), of which 50% is found in the spinal canal (25% in adults), resulting in greater dilution of intrathecal drugs. On the other hand, neonates have large neuronal structures in proportion to their skeletal mass, and the low concentration of Ranvier nodules means that high concentrations of local anesthetics are required.[11,12]

Table 2 – Drugs used for spinal anesthesia in pediatrics.

Medication	Dose	Age
Tetracaine 0.5%	0.6–0.8 mg/kg (low or intermediate level)	Neonates
	1 mg/kg (high level)	
Bupivacaine 0.5%	0.6–0.8 mg/kg (low-intermediate level)	Neonates
	1 mg/kg (high level)	
	0.5 mg/kg	Infants <10 kg
	0.4 mg/kg	Children 11–19 kg
	0.3 mg/kg	Children and adolescents >20 kg
Levobupivacaine 0.5%	1 mg/kg	Neonates
	0.3 mg/kg	1–14 years
Ropivacaine	1.08 mg/kg	Neonates
0.5%	0.5 mg/kg	1–17 years
Lidocaine 2%	2 mg/kg	Children <13 years
Fentanyl	1 μg/kg	Infants <1 year
Morphine	4–5 μg/kg	All ages
Clonidine	1 μg/kg	Neonates
Neostigmine	0.75 μg/kg	Infants <1 year

Taken from Lopez T et al. Spinal anesthesia in pediatric patients. Minerva Anestesiol, 2012; 78(1): 78-87. Printed with con permission.

Spinal anesthesia in the pediatric population does not alter hemodynamic stability, and this is a relevant consideration. It has been observed that blood pressure and heart rate are maintained even with blocks at T4 without previous hydration. This is explained by the fact that infants have less venous capacitance in their lower limbs, depend less on the vasomotor tone, and have parasympathetic predominance.[13]

Ventilation will not be affected as long as the block does not go beyond T1, because neonates maintain their breathing primarily with the support of the diaphragm.[14]

For infraumbilical procedures, a T8–T9 level is sufficient. The most commonly used drugs are 0.5% bupivacaine and 0.5% tetracaine. The recommended dose to obtain mean spinal blocks is 0.6–0.8 mg/kg and the duration of the block with the two drugs ranges between 90 and 120 min. Pediatric patients between six months and 14 years of age require a lower dose, and hyperbaric bupivacaine is indicated at 0.3 mg/kg with a 98% success rate.[15] Recently, 0.5% ropivacaine at 0.5 mg/kg[16] and 0.5% levobupivacaine at 0.3 mg/kg have been used in children 1–14 years of age with a lower incidence of toxicity and motor blockade, and this is recommended in cases of liver dysfunction (see Table 2).

Hypoxemia, intraoperative apnea and bradycardia are frequent complications in premature babies and neonates, possibly as a result of high spinal blockade, excess sedation during the procedure, or maximum neck flexion during the lumbar puncture. Other complications have been described, including post-puncture headache – ranging from 0.4% to 15% depending on the type of procedure and the size of the needle[17,18] – transient neurologic syndrome (1.5%), and menigitis.[19]

Neuroaxial alpha-2 agonist in pediatrics

Clonidine, prototype of alpha-2 agonists, acts on the presynaptic and post-synaptic alpha-2 adrenergic receptors, and has also a weak action on the alpha-1 receptors. It is indicated as a centrally acting antihypertensive drug, and in regional anesthesia for sedation and analgesia as an adjunct for opioids in the treatment of pain.

In the pediatric population, clonidine is used at 0.5–5 μg/kg given to the subarachnoid space without producing ventilation or hemodynamic compromise.[20] Different authors suggest caution in children under 1 year of age or weighing less than 10 kg until studies with a higher level of evidence support its use.

Neuroaxial clonidine at higher doses may lead to hypotension, bradycardia and sedation.[21] Hypotension is considered as an interaction in the spinal cord vasomotor center, localized in the lateral reticular nucleus of the brain stem, leading to a reduced norepinephrine turnover from the sympathetic endings to the peripheral tissues. Bradycardia is secondary to parasympathetic hyperstimulation and concurrent reduction of the sympathetic tone.[22] The sedative effect has a central action.

Remifentanil for sedation in regional anesthesia

Remifentanil is an ultra short acting opioid used primarily in adults for anesthesia and conscious sedation in painful procedures. There are few references about its use in the pediatric literature.[23–27]

Its main advantages relate to the rapid onset and cessation of its clinical effects (maximum effect lasting 90–120 s). Analgesic plasma concentration is 0.5–1.5 μg/ml. The optimal balance between patient comfort and safety requires careful dosing of the drug under adequate monitoring of the central nervous, cardiovascular and respiratory systems, and good communication with the patient and the surgeon or interventional specialist.

In deep sedation, airway protection reflexes are altered, increasing the risk. Multi-center trials propose remifentanil for sedation analgesia combined with locoregional anesthesia, starting the infusion at a rate of 0.1 μg/kg/min until the blockade is completed, and continuing at a rate of 0.05 μg/kg/min until the end of the procedure;[28] this permits autoprotection of the airway without the need for manipulation.

Conclusions

There is evidence in the literature of the advantages and low risk of spinal anesthesia in pediatrics when compared with general anesthesia.[29] It has been shown to be highly effective and efficient in the hands of experienced anesthesiologists. However, it continues to be underutilized by most institutions and anesthesiologists.

Intrathecal clonidine, an alpha-2 agonist, is used as an adjunct to local anesthetics allowing a dose reduction and diminishing their deleterious side-effects.

Remifentanil is a good option for conscious sedation in locoregional anesthetic procedures in pediatric patients, maintaining good hemodynamic stability and spontaneous ventilation. The anesthesiologist is required to perform adequate and close monitoring due to the risk of respiratory depression which, in most cases, only requires reducing or interrupting the infusion or stimulating the patient.

Funding

The authors' own resources.

Conflict of interests

None declared.

REFERENCES

1. Bier A. Versuche ueber Cocainisirung des Rueckenmarkes. Deutsche Zeitschrift Chirugie. 1899;51:361–8.
2. Williams RK, Abajian JC. High spinal anaesthesia for repair of patent ductus arteriosus in neonates. Paediatr Anaesth. 1997;7:205–9.
3. Arora MK, Nagaraj G, Lack ST. Combined spinal and epidural anaesthesia for a child with Freeman-Sheldom syndrome with difficult airway. Anesth Analg. 2006;103:1624.
4. Fiadjoe J, Stricker P. Pediatric difficult airway management: current devices and techniques. Anesthesiol Clin. 2009;27:185–95, http://dx.doi.org/10.1016/j.anclin.2009.06.002.
5. Astuto M, Sapienza D, Di Bennedetto V, Disma. Spinal anesthesia for inguinal hernia repair in an infant with Williams syndrome: case report. Paediatr Anesth. 2007;17:193–5.
6. Shenkman Z, Sheefer O, Erez I, Litmanovitc I, Jedeikin R. Spinal anesthesia for gastroctomy in an infant with nemaline miopaty. Anesth Analg. 2000;91:858–9.
7. Tobias JD. Combined general and spinal anaesthesia in an infant with single ventricle physiology undergoing anorrectoplasty for an imperforate anus. J Cardiothorac Vasc Anesth. 2007;21:873–5.
8. Forber N, Troshynki TJ, Turco G. Spinal anesthesia in an infant with epidermolysis bullosa. Anesthesiology. 1995;83:1364–7.
9. Bosenberg AT, Gouws E. Skin-epidural distance in children. Anaesthesia. 1995;50:895–7.
10. De Negri P, Perrota F, Tirri T, De Vivo P, Ivani J. Spinal anesthesia in children. Minerva Anesthesiol. 2001;67:121–5.
11. Saint-Maurice C. Spinal anesthesia in infants, children and adolescents. London: Williams and Wilkins; 1995. p. 261–73.
12. Dohi S, Naito H, Takahashi T. Age-related changes in blood pressure and durations of motor block in spinal anesthesia. Anesthesiology. 1979;50:319–23.
13. Tobias JD. Spinal anaesthesia in infants and children. Paediatr Anaesth. 2000;10:5–16.
14. Marc J, Ortell SJ. Anesthesia Subaracnoidea. In: Blanco D, Reinoso F, editors. Anestesia locorregional en pediatría. Madrid: Aran Ediciones, SL; 2005. p. 151–62.
15. Puncuh F, Lampugnani E, Kokki H. Use of spinal anesthesia in a paediatric patient: a single centre experience with 1132 cases. Paediatr Anaesth. 2004;14:564–7.
16. Kokki H, Ylonen P, Laisalmi M, Heikkinen M, et al. Isobaric ropivacaine 5 mg/ml for spinal anesthesia in children. Anesth Analg. 2005;100:66–70.
17. Apiliogullari S, Duman A, Gok F, Akillioglu I. Spinal needle design and size affect the incidence of postdural puncture headache in children. Paediatr Anaesth. 2010;20:177–82 [Epub 2009 Dec 11].
18. Kokki H, Salonvaara M, Herrgand E, Unen P. Postdural puncture headache is not an age-related symptom in children. A prospective open-randomized, parallel group study comparing a 22 gauge Quincke with a 22 gauge Whitacre needle. Paediatr Anaesth. 1999;9: 429–34.
19. López T, Sánchez FJ, Garzón JC, Muriel C. Spinal anesthesia in pediatric patients. Minerva Anestesiol. 2012;78:78–87 [Epub 2011 Dec 28] Review.
20. Rochette A, Raux O, Troncin R, et al. Clonidine prolongs spinal anesthesia in newborns, a prospective dose-ranging study. Anesth Analg. 2004;98:56–9.
21. Castro MI, Eisenach JC. Pharmacokinetics and dynamics of intravenous, intrathecal, and epidural clonidine in sheep. Anesthesiology. 1989;71:418–25.
22. González de N, Mejía. Analgesia multimodal postoperatoria. Rev Soc Esp Dolor Narón (La Coruña). 2005;12.
23. Cao JP, Miao XY, Liu J, Shi XY. An evaluation of intrathecal bupivacaine combined with intrathecal or intravenous clonidine in children undergoing orthopedic surgery: a randomized double-blinded study. Paediatr Anaesth. 2011;21:399–405.
24. López-Andrade A, Prieto-Cuéllar M, García-Sánchez MJ, Martín-Ruiz JL. Sedación de pacientes en las técnicas dolorosas diagnósticas y terapéuticas: supuestos clínicos. Rev Soc Esp Dolor. 2004;8:15-23.
25. Kim EJ, Shin SW, Kim TK, Yoon JU, Byeon GJ, Kim HJ. The median effective effect-site concentration of remifentanil for minimizing the cardiovascular changes to endotracheal intubation during desflurane anesthesia in pediatric patients. Korean J Anesthesiol. 2012;63:314–20.
26. Stoppa F, Perrotta D, Tomasello C, Cecchetti C, Marano M, Pasotti E, et al. Low dose remifentanyl infusion for analgesia and sedation in ventilated newborns. Minerva Anestesiol. 2004;70:753–61.
27. Welzing L, Roth B. Experience with remifentanil in neonates and infants. Drugs. 2006;66:1339–50 [Review].
28. Mingus ML, Monk TG, Gold MI, Jenkins W, Roland C, Remifentanil 3010 Study Group. Remifentanil versus propofol as adjuncts to regional anesthesia. J Clin Anesth. 1998;10:46–53.
29. Cohen M, Cameron C, Duncan P. Pediatric anaesthesia morbidity and mortality in the perioperative period. Anesth Analg. 1990;70:160–7.