First Realizations of Spinal Anesthesia in Neonates and Infants - Preterms or Ex prematures - in Antananarivo, Madagascar

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Research note

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Abstract

Objective: The aim of this study was to describe the first realizations of spinal anesthesia in neonates and infants (preterms or ex prematures) in Antananarivo - Madagascar, because spinal anesthesia – a low cost technique – can limit respiratory complications and postoperative apnea and also general anesthesia can present perioperative risks for pediatric patients.

Results: In a retrospective, descriptive, seven-year (2013 to 2019) period study, conducted in the University Hospital Joseph Ravoahangy Andrianavalona, data files of 69 babies planned to have spinal anesthesia were recorded. These pediatric patients were predominantly male (sex ratio = 2.8) and 37 [28 - 52] days old. The smallest anesthetized child weighed 880 g; the youngest was 4 days old. Twenty-seven (27) of them were premature and 20.3% presented respiratory diseases. They were mostly scheduled for hernia repair (97.1%). Spinal anesthesia was performed, with a Gauge 25 Quincke spinal needle, after 2 [1 - 2] attempts with hyperbaric bupivacaine of 4 [3.5 - 4] mg. Failure rate was 5.8% needing general anesthesia conversion. The heart rate was stable throughout perioperative period and no complications were observed.

Introduction

Spinal anesthesia (SA) is a part of anesthesia for sub umbilical and lower limb surgeries [1]. The first spinal anesthesia in children had been practiced by Bier in the 19th century (1898), then by Bainbridge (1901) and Gray (1909) [1, 2]. In the middle of 20th century, this regional anesthesia technique was abandoned, because of considerable improvements of general anesthesia (GA) [2]. Nowadays, it tends to be more practiced in children, as much in the newborns as in the preterms in order to prevent and to reduce respiratory complications, apnea and bradycardia [1–3]. Hernia repairs are the most concerned surgeries which could be done under spinal anesthesia; this latter also provides perioperative analgesia [1, 4, 5].

In Antananarivo - Madagascar, at the Hospital University of Joseph Raseta Andrianavalona (CHU JRA), general anesthesia (particularly inhalatory GA with halothane then sevoflurane) is the more used in pediatric anesthesia. Since 2013, spinal anesthesia has started to be performed at the CHU JRA.

The aim of this study was to present the first realizations of spinal anesthesia, in newborns and infants (preterms / ex-prematures) and to determine its feasibility and its potential harmlessness, in Antananarivo.

Methods

A retrospective, observational, descriptive study was conducted; by collecting data from scheduled sub umbilical pediatric surgeries under spinal anesthesia, from 2013 to 2019 (seven-year period), at the CHU JRA. This latter is the surgical reference center of Madagascar, particularly in pediatric surgery.

Informed consent was obtained from the parents, after explanation of SA technique and possible significant risk of GA, during the anesthesia consultation (AC)of their child. This AC was carried out and validated by a team of two anesthesiologists (who also carry out the spinal anesthesia, in order to limit the bias in performance).

Were studied **(i)** the **gender**, **(ii)** the **perinatal parameters** (weeks of amenorrhea (WA) at birth, prematurity, causes of prematurity), birth weight, **(iii)** the **parameters during the AC**: age of the patient [in days and in "postconceptional age" (PCA) (expressed in corrected WA [CWA] for preterms or ex prematures)], and weight, **(iv) data relating to spinal anesthesia** (the SA performer, the position of the patient, the material used during the procedure, the localization of the lumbar puncture, the number of lumbar punctures, the injected dose of bupivacaine, the incidents relating to spinal anesthesia), **(v) the other parameters** : the adjuvant anesthetic procedures (particularly the general anesthesia conversion), the surgical data (indications and duration of the surgery), the length of stay in the postoperative recovery room and **(vi) the heart rate from before SA to admission to recovery room**. The continuous variables are expressed in median [interquartile 25% – 75%] and the categorical variables in frequencies.

Results

Over the period observed, 69 babies were planned to have spinal anesthesia (*Figure S1*) for their surgery. The patients were predominantly male (sex ratio = 2.8) and 37 [28–52] days old. The smallest anesthetized child weighed 880 g and the youngest was 4 days old. They were weighing 2400 [1995–3025] g at birth and 3450 [2800–4240] g on the day of the anesthesia consultation. Twenty-seven (27) of them were preterms, with a corrected age of 40.5 [37–42] CWA. Fourteen children (20.3%) had a medical history of respiratory diseases. The Table 1 summarizes the characteristics of the patients.

Table 1
Population study characteristics

		n	%
Pediatric patients	Newborns	18	26.0
	Infants	51	73.9
Preterms or ex-prematures		27	39.1
Weight at the anesthesia consultation (g)	< 1000	1	1.4
	[1000–2000[	2	2.9
	[2000–3000[	17	24.6
	[3000–4000[	24	34.8
	[4000–5000[	16	23.2
	[5000–6000[	7	10.1
	≥ 6000	2	1.4
Medical history	Respiratory diseases[a]	14	20.3
	Resuscitation at birth	3	4.3
	Incubator after birth	6	8.7
	Others[b]	3	4.3
Causes of prematurity	Anamnios or Oligoamnios	4	5.8
	Gestational diabetes and/or pregnancy-induced hypertension	8	11.6
	Pre-eclampsia or Eclampsia[c]	6	8.7
	Maternal fetal infections	4	5.8
	Placenta prævia	1	1.4
	Twin pregnancy	1	1.4
	PROM[d] + cord prolapse	1	1.4
	Fetal anoxia[c]	2	2.9

[a] *Respiratory diseases = meconial amniotic fluid inhalation at birth, bronchiolitis;* [b] *Others = intrauterine growth restriction (IUGR), neonatal infection, gastroesophageal reflux;* [c] *+/- other conditions (preeclampsia, twin pregnancy);* [d] *PROM = premature rupture of fetal membranes.*

The length between the AC and the intervention was 5 [3–13] days. The indications for the interventions are shown in Table 2. They were dominated by hernias (inguinal, inguinoscrotal and ovarian). The duration of the surgical procedure was 27.5 [17.5–40.0] minutes ranging from 10 to 65 minutes.

Table 2
Perioperative characteristics

			n	%
Surgery	Hernia (inguinal and/or scrotal) +/- circumcision		49	71.0
		- bilateral hernia	*25*	*36.2*
		- right hernia	*15*	*21.7*
		- left hernia	*9*	*13.0*
	Bilateral ovarian hernia		18	26.1
	Surgery of lower limbs (gangrene / necrosis)		2	2.9
Spinal anesthesia (SA)	Position of the patient	Lateral decubitus	9	13.0
		Sitting position	60	87.0
	Number of punctures	1	34	47.3
		2	22	31.9
		≥ 3	13	18.8
	Incidents during the technique (blood reflux)	- CSF[a] reflux after a first blood reflux	1	1.4
		- CSF[a] reflux after a 2nd puncture	4	5.8
	Failure of SA	- due to the technique[b]	2	2.9
		- due to the local anesthetic	2	2.9
	General anesthesia (GA) conversion		4	5.8

[a] *CSF = Cerebral Spinal Fluid;* [b] *= blood reflux without secondary CSF reflux or after 2nd lumbar puncture.*

For all children, a prior intravenous cannulation (G24) was placed and fixed in the upper limbs, for perioperative perfusion. For all the patients, the performers of spinal anesthesia were two medical anesthetists with prior training in this technique. The child was kept with a curved back, in a sitting or lateral decubitus position, by a trained assistant. The spinal puncture was performed in the intersection between Tuffier's line and the vertebral axis. The used material was an 80 mm – G25 Quincke spinal needle (the thinnest needles available at the CHU JRA). The attempts of punctures were 2 [1–2]. The GA conversion was 5.8%. The dose of bupivacaine administered was 4 [3.5–4] mg. The technique was successful when the reflux of cerebrospinal fluid was present and the infiltration of the local anesthetic was easy. Then, the patient was placed directly in a 45° head up tilt - head up. Spinal anesthesia was also considered successful, when the patient no longer moved his lower limbs, and/or presented relaxation of the anal sphincter, and also in the absence of GA conversion or complementary local anesthesia (by the surgeon) throughout the surgical procedure. If SA was successful, a pacifier dipper in sugar water was given to the baby.

The heart rate was stable throughout anesthesia and surgical procedure; a slight decrease in this frequency was observed after spinal infiltration (Fig. 1).

For all pediatric patients of this study, oral paracetamol (acetaminophen) was administered in recovery room where duration of stay was 70 [60–120] minutes. No peroperative and postoperative complications were observed.

Discussion

The present study represents the first series of spinal anesthesia performed in pediatric patients, in a hospital center in Madagascar. Over a seven-year period, 69 children were scheduled for spinal anesthesia, with a GA conversion following failure rate of 5.8%.

1. Incidence, clinical features and indications of pediatric spinal anesthesia

The indication of spinal anesthesia was mainly limited to the situations where general anesthesia leaded a great risk for the child, especially respiratory risk [1, 4, 6]). After the decline of caudal anesthesia in the years 1990–2000, SA had an upsurge of 2.1 to 3.6% in regional anesthesia techniques, even if spinal anesthesia in newborns (or even in premature infants) is controversial [3, 7]. Plus, SA is the “gold standard” technique in the former preterm infant (< 60 weeks PCA) for lower abdominal and lower extremities surgeries under 90 minutes duration [2]. In a work by Williams R.K. et al. [8] spinal anesthesia was performed in 95.4% of children. In France, this technique represents 18% of regional anesthesia in preterms and 5% in newborns [3]. In Finland, 400 to 500 spinal anesthesias are performed annually [6]. As related in the present study, first spinal anesthesias in Antananarivo were performed in 2013, with 69 cases in seven years, for surgeries ranging 10 to 65 minutes.

The success of the technique was estimated on the reflux of cerebrospinal fluid (CSF) which was 97.1% in the present study, almost similar to the rate of 97.4% reported by Williams R.K. et al. [8]. One lumbar puncture was perfomed in 47.3% and general anesthesia conversion was 5.8%. Sedation is often necessary, during insufficient block and the conversion to general anesthesia is indicated in case of failure of the technique [3]. Dohms K. et al. [9] find a failure rate of 7.5% and in 28% cases, more than two punctures were needed and 16% required supplemental anesthesia. In Kachko L.'s [4] study, general anesthesia conversion occurred in 1.04%.

The success of the spinal anesthesia was estimated and based on the motor skills of the lower limbs and the relaxation of the anal sphincter (when present), as well as the effectiveness of the surgical gesture. The use of general anesthesia after spinal puncture was 2.9% due to the quality of the product. Since the Bromage score is not assessable in this population category, the effectiveness of spinal anesthesia can be assessed by the possibility of performing the surgical procedure [10].

The dose of bupivacaine used in our series is 4[3.5-4] mg. The most commonly used local anesthetics are 0.5% tetracaine and 0.5% bupivacaine; the usual dose is 0.6–0.8 mg / kg to reach average levels, and 1 mg / kg for higher levels (thoracic) [1]. These two molecules act during 90 to 120 minutes [1].

2. Spinal anesthesia, safe and real alternative to general anesthesia?

Spinal anesthesia offers an interesting and reassuring alternative if tracheal intubation should be avoided by the underlying pathologies such as bronchopulmonary dysplasia or respiratory diseases [1, 7]. Indeed, spinal anesthesia can avoid apnea or bradycardia and have minimum cardiorespiratory complications [2, 6, 10, 11]. In the cases presented, most of the children presented an anesthetic risk in case of general anesthesia, due in particular to respiratory diseases and very young age (20.3% of rhino-bronchitis, and 39.1% of prematurity). This situation motivated indication of spinal anesthesia in the CHU JRA.

Spinal anesthesia offers a good balance between safety and perioperative risks and seems to be a secured technique for the operated child, as long as compliance with contraindications is observed [5, 6, 11]. SA is more effective in blunting the neuroendocrine stress and adverse effects of surgery and provides additional effective intraoperative analgesia [2, 12].

Spinal anesthesia in children allows remarkable cardiovascular stability [13, 14]. The frequency of complications is 30% [1]. Ventilation and oxygenation are not generally compromised, even in patients at high risk, in preterm and expremature [13, 14]. SA has a moderate risk of apnea and bradycardia (RR = 0.72), desaturation (RR = 0.82) and a low risk of needing postoperative respiratory assistance (RR = 0.09) [12].

In this work, no bradycardia of less than 100 bpm was observed, probably due to the very slow infiltration of the anesthetic and the 45° head up tilt position of the patient directly after infiltration. No other complications arose during these SA.

In addition, spinal anesthesia can provide other benefits, such as a shorter length of stay compared to the length of stay after general anesthesia as well as faster recovery of gastrointestinal function [14].

3. Spinal anesthesia in developing countries? And .... in Madagascar?

The use of spinal anesthesia especially in “precarious” or “difficult” situations is attractive because it requires fewer perioperative resources [15]. However, a conversion to general anesthesia in case of failure could incur higher costs, hence the need for some experience in the gesture and a well knowledge of the technique. Very few studies on spinal anesthesia in children, much less in infants, newborns and preterms / ex-prematures, in low-incomes countries, have been found.

Ela A.A. et al. [16] report a series of 55 patients from one day to 16 years old, operated under spinal anesthesia with bupivacaine associated with fentanyl, with a Whitacre 25 G or 22 G needle. The spinal anesthesia performed in their study population was performed by **(i)** either an intensivist, **(ii)** or an anesthesia-intensivist resident, **(iii)** or a state-certified nurse anesthetist [16]. The indications were predominantly inguinal and scrotal hernias (48.15%), and surgeries range from 25 minutes to 78 minutes [16]. No complications were found in their study. Due to the many categories of age of the patients in the Ela A.A. et al. [16] study, the results of our study differ from theirs, particularly in terms of the puncture site and the products used.

In Antananarivo, this series is the first to have been mentioned. The strength in our results is the specificity of the study population (preterms, newborns, infants). These first results being apparently acceptable, this technique should be extended, nevertheless after training of anesthesiologists. Indeed, this technique requires a high level of skill, particularly if it is carried out in very little patients, who are "non-cooperating" with small anatomical dimensions [1, 13]. The failure rate is 28% and the risk of total spinal anesthesia is possible (around 0.63 to 0.8%), especially since anesthesia trainees have a significant different success rate compared to anesthesiologists (83% vs 98.9%) [1, 8].

Conclusion

Spinal anesthesia is a regional anesthesia technique widely used in developed countries, and is very interesting, especially in newborns and preterms. In Madagascar, this technique should be extended, due to its low cost and the safety that this technique offers, especially avoiding respiratory complications and apnea.

Limitations

The monocentric and retrospective nature of this study are the main limits and the presented results do not reflect the whole Malagasy population.

Abbreviations

AC: Anesthesia Consultation

CHU JRA: Centre Hospitalier Universitaire Joseph Ravoahangy Andrianavalona

CSF: Cerebral Spinal Fluid

CWA: Corrected Weeks of Amenorrhea

G: Gauge

GA: General Anesthesia

PCA: Postconceptional Age

RR: Risk Ratio

SA: Spinal Anesthesia

WA: Weeks of Amenorrhea

Declarations

Ethics approval and consent to participate:

The indication of spinal anesthesia depends of the status of the patient and this indication was made at the discretion of the anesthesiologist after the anesthesia consultation. The study was approved by the CHUJRA hierarchy. A written informed consent was taken from parents of anesthetized patients prior to data collection. They were informed of the SA and gave their consent before the realization of the surgical and anesthesia procedure

Availability of data and materials:

- Spinal anesthesia procedure at the CHU JRA (figure S1) : materials used, position, puncture)
- Data and materials are available (Excel®) from the corresponding author

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Consent for publication:

Informed consent was obtained for the study, all patients’data were anonymously analyzed

Competing interests:

The authors have no conflict of interest

Author’s contributions:

- Randriamizao, Rakotondrainibe: redaction, data analysis, anesthesia performers
- Razafindrabekoto: bibliographic research
- Ravoaviarivelo: data collection and anesthesia assistant
- Rajaonera, Andriamanarivo: revision and approval

References

1. Lopez T, Sanchez FJ, Garzon JC, Muriel C. Spinal anesthesia in pediatric patients. Minerva Anestesiol 2012;78(1):78-87.
2. Gupta A, Saha U. Spinal anesthesia in children: a review. J Anaesthesiol Clin Pharmacol 2014;30(1):10-8.
3. Frawley G, Ingelmo P. Spinal anaesthesia in the neonate. Best Pract Res Clin Anaesthesiol 2010;24(3):337-351.
4. Kachko L, Simhi E, Tzeitlin E, Efrat R, Tarabikin E, Peled E, et al. Spinal anesthesia in neonates and infants – a single-center experience of 505 cases. Paediatr Anaesth 2007;17(7): 647-53.
5. Wiegele M, Marhfer P, Lönnqvist PA. Caudal epidural blocks in pediatric patients: review and practical considerations. Br J Anesth 2019;122(4):509-17.
6. Kokki H. Spinal blocks. Paediatr Anaesth2012;22(1):56-64.
7. Nickel US, Meyer RR, Brambrink AM. Spinal anesthesia in an extremely low birth weigth infant. Paediatr Anaesth 2005;15(1):58-62.
8. Williams RK, Adams DC, Aladjem EV, Kreutz JM, Sartorelli KH, Vane DW, et al. The safety and efficacy of spinal anesthesia for surgery in infants: the Vermont infant spinal registry. Anesth Analg 2006;102(1):67-71.
9. Dohms K, Hein M, Rossaint R, Coburn M, Stoppe C, Ehret CB, et al. Inguinal hernia repair in preterm neonates: is there evidence that spinal or general anesthesia is the better option regarding intraoperative and postoperative complications? A systematic review and meta-analysis. BMJ Open 2019;9(10):e028728.
10. Suresh S, Hall SC. Spinal anesthesia in infants: is the impractical practical? Anesth Analg 2006;102(1):65-6.
11. Kurth CD, Coté CJ. Postoperative apnea in former preterm infants. General anesthesia or spinal anesthesia – Do we have an answer? Anesthesiology 2015;123(1):15-7.
12. Jones LJ, Craven PD, Lakkundi A, Foster JP, Badawi N. Regional (spinal, epidural, caudal) versus general anesthesia in preterm infants undergoing herniorraphy in early infancy (Review). Cochrane Database of Systematic Reviews 2015;6: CD003669.
13. Gerber AC, Weiss M. Awake spinal or caudal anesthesia in preterms for herniotomies: what is the evidence based benefit compared with general anesthesia? Curr Opin Anesthesiol 200;16(3):315-20.

14. Tirmizi H. Spinal anesthesia in infants: recent developments. Curr Opin Anesthesiol 2015;28(3):333-8.
15. Komorowski M, Fleming S, Mawkin M, Hinkelbein J. Anaesthesia in austere environments: literature review and considerations for future space exploration missions. Npj Microgravity 2018;4(1):1-11.
16. Ela AA, Ngayap G, Owono Etoundi P, Esiene A, Bengono R, Mikone A. La rachianesthésie chez l'enfant : bilan d'une année d'expérience à l'Hôpital Central de Yaoundé. Health Sci Dis 2013 ; 14(4).

Figures

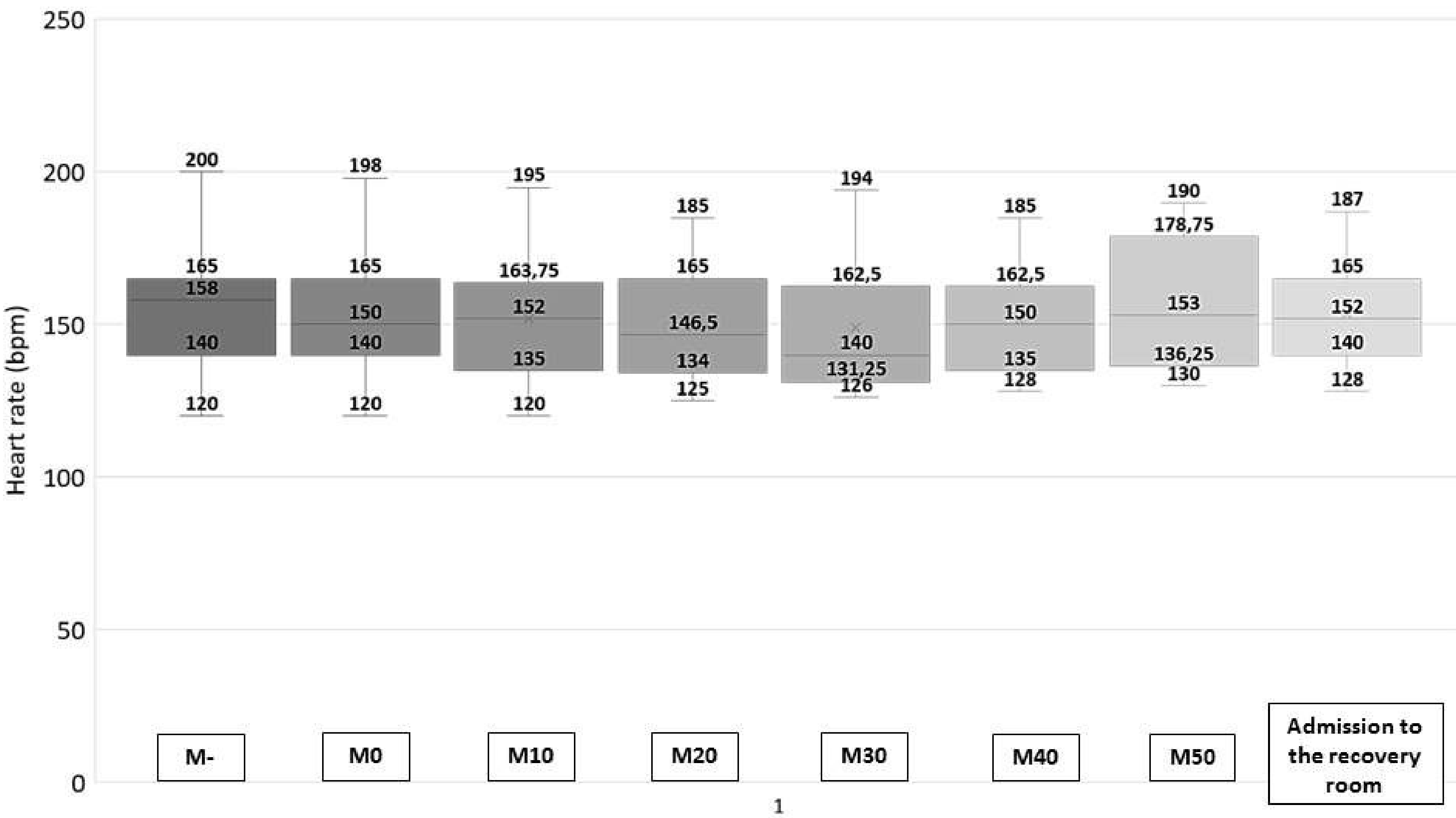

Figure 1

Perioperative heart rate of the patients under spinal anesthesia (expressed in median, interquartile 25% - 75%, minimum and maximum). bpm = beat per minute; M = minute.

Supplementary Files

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- supplement1.docx
- supplement2.xlsx