Use of Spinal Anaesthesia In Neonates And Infants In Antananarivo, Madagascar: A Retrospective Descriptive Study

Harifetra Mamy Richard Randriamizao
Université d'Antananarivo
Aurelia Rakotondrainibe (aaurelia.rakotondrainibe@gmail.com)
Université d'Antananarivo https://orcid.org/0000-0002-9555-3403
Lova Dany Ella Razafindrabekoto
Universite de Fianarantsoa
Prisca Funken Ravoaviarivelo
CHU Joseph Ravoahangy Andrianavalona
Andriambelo Tovohery Rajaonera
Université d'Antananarivo
Mamy Lalatiana Andriamanarivo
Université d'Antananarivo

Research note

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Abstract

Objective: The aim of this study was to present the first cases of spinal anesthesia, in newborns and infants, preterm / ex-prematures, in order to determine its feasibility and its potential harmlessness, in Antananarivo – Madagascar. Indeed, spinal anesthesia is a low cost technique and can limit respiratory complications, postoperative apnea *a contrario* with pediatric general anesthesia which can lead to perioperative risks.

Results: In a retrospective, descriptive, seven-year (2013 to 2019) period study, conducted in the University Hospital Joseph Ravoahangy Andrianavalona, 69 patients' data files 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 880g; 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 (90%). 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%. 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 was abandoned, because of considerable improvements of general anesthesia (GA) **[2]**. In 1990-2000, spinal anesthesia in newborns or in preterms, had an upsurge of 2.1 to 3.6% in regional anesthesia after the decline of caudal anesthesia practice **[3, 4]**. Nowadays, SA tends to be more performed in pediatric anesthesia, up to 95.4% of children, as much in the newborns as in the preterms **[1-3, 5]**. SA allows to prevent and to reduce perioperative complications even if its duration is an important limiting factor **[1-3, 6]**. Because of this limitation, short surgery duration is the more indicated under SA **[1, 5, 7]**. For more efficiency, this technique should be performed by experimented anesthetists **[1, 8]**.

In Antananarivo - Madagascar, at the Hospital University of JR Andrianavalona (CHU JRA), since 2013, spinal anesthesia has started to be performed. The aim of this study is to present the first cases of spinal anesthesia, in newborns and infants, preterms / ex-prematures, in order to determine its feasibility and its potential harmlessness, in Antananarivo.

Methods

A retrospective, observational, descriptive study was conducted, from 2013 to 2019, at the operating theater of the CHU JRA (the surgical reference center of Madagascar, particularly in pediatric surgery).

The data files from scheduled pediatric surgeries under spinal anesthesia were analyzed. The studied variables and parameters were **(i) gender**, **(ii) perinatal parameters**: weeks at birth, prematurity (with causes), birth weight, **(iii) parameters during the anesthesia consultation (AC)**: age (in days), postconceptual age (in corrected weeks [CW] for preterms or ex prematures), and weight, **(iv) spinal anesthesia parameters**: procedure of lumbar puncture and spinal anesthesia, **(v) perioperative variables**: complementary procedures during SA, surgery characteristics, length of stay in the postoperative recovery room and **(vi) perioperative heart rate**.

The general anesthesia risks and modalities of spinal anesthesia were explained to the patients'parents, during the AC, which was carried out and validated by a team of two anesthesiologists (also the performers of the SA) who had prior training in SA of small children.

The lumbar puncture was considered as successful when the cerebrospinal fluid (CSF) flows back. Then, the patient was placed in a 45° tilt-head up. The local anesthetic (LA) used was hyperbaric 0.5% bupivacaine (1mg/kg = 0.2mL/kg). Spinal anesthesia was considered successful, when the patient no longer moved his lower limbs or had anal sphincter relaxation; and also when GA conversion or complementary local anesthesia (by the surgeon) throughout the surgical procedure was no needed. When spinal anesthesia was successful, a pacifier dipper with sugar water was given to the baby.

The continuous variables are expressed in median [interquartile 25% - 75%] and the categorical variables in frequencies.

Results

Over the 7-years period, 69 SA were indicated (*Figure S1*) in predominantly male (*sex ratio* = 2.8) and 37 [28 - 52] days old patients (*Table I*). The smallest patient weighed 880 g and the youngest was 4 days old. The patients were weighing 2400 [1995 - 3025] g at birth and 3450 [2800 - 4240] g on the day of the AC. Twenty-seven patients were preterms, aged 33 [27-37] weeks at birth and with a corrected age of 40.5 [37 - 42] CW on the day of the anesthesia. Fourteen children (20.3%) had a medical history of respiratory diseases. The intervention was performed 5 [3 - 13] days after the AC. The main surgery indications (*Table II*) were hernias and surgical procedure was 27.5 [17.5 - 40.0] ranging from 10 to 65 minutes. For all patients, perioperative perfusion was performed with a 24G intravenous catheter. The lumbar puncture was performed on a curved back patient, in a sitting or lateral decubitus (if sedated) position, by a trained assistant. The puncture was performed in the intersection between the line connecting the highest point of both iliac crests and the vertebral axis. The localization of lumbar puncture was determined by palpation, by the SA performer. The used material was an 80mm – G25 Quincke spinal needle (the thinnest needle available at the CHU JRA). Inhalatory sedation was needed in 13.0%, when positioning patient was difficult. The number of punctures was 2 [1 - 2] attempts. A dose of 4 [3.5 - 4] hyperbaric 0.5% was administered. The lumbar puncture was successful in 97.1% and spinal anesthesia in 94.2%. No complementary local anesthesia by the surgeon was required. The GA conversion was 5.8% when SA failed.

The heart rates were slight constant throughout intervention until admission to recovery room (*Figure 1*). The patients stayed in postoperative recovery room during 70 [60-120] minutes. No perioperative complications were observed.

Discussion

In the present study, spinal anesthesia was scheduled for 69 babies. This series represents the first pediatric spinal anesthesia, performed since 2013, in Madagascar. In developed countries, such as in United States, SA was included since 1977, with 262 SA, on less than 1-year patients, in 15 years **[9]**. Williams R.K. et al. **[5]** reported 95.4% pediatric spinal anesthesia. In Europe, 400 to 500 SA are performed annually, with 18% in preterms and 5% in newborns **[3, 10]**. In other countries, like India, in a one-year period study, 102 children (from 6 months to 14 years) received spinal anesthesia for subumbilical and lower limb orthopedic surgeries **[6]**. In low-incomes countries, few studies on pediatric spinal anesthesia have been related. For instance, Ela A.A. et al. **[11]**, in Cameroon, report a series of 55 children operated under spinal anesthesia. However, the use of spinal anesthesia especially in “precarious” or “difficult” situations is attractive because it requires fewer perioperative resources **[12]**.

Spinal anesthesia in the present study was performed, even in very young age (27 were preterms) and low weight child, and 14 children had medical history of respiratory diseases. Spinal anesthesia is primarily indicated when general anesthesia is at high risk (= respiratory complications or postoperative apnea because of pulmonary disease or prematurity) **[1, 7, 10, 13]**. SA is the “gold standard” technique in preterms (gestational age ≤37 weeks) and high-risk patients (preterm infants with postconceptual age <60 CW) **[2, 9]**. Indeed, this population is at high risk of postoperative apnea, especially if general anesthesia is performed. Spinal anesthesia is a safe alternative when tracheal intubation should be avoided (due to bronchopulmonary dysplasia or respiratory diseases, …) **[1, 4]**. Indeed, spinal anesthesia can reduce or avoid apnea **[9, 10]**. Also, SA generates minimum respiratory complications **[2, 10, 14, 15]**. In this study, most of the patients had respiratory diseases and some were very young (20.3% rhino-bronchitis, and 39.1% prematurity). All these facts motivated spinal anesthesia in the present study. In addition, the characteristics of the patients were quite similar with a study by Hermanns H et al. **[13]**: 34.5 (24–40) weeks at birth, 10 (5–24) weeks postnatal age at the time of the intervention, and 3.5 (2.2–5.2) kg in weight.

The surgeries (lasting 27.5 [17.5 - 40.0]), in the present study, were mostly hernia repairs. Spinal anesthesia is the gold standard for lower abdominal and lower limbs surgeries under 90 minutes duration **[1, 2, 5, 7]**. This was similar with a study of Ela A.A. et al. **[11]** (25 minutes to 78 minutes) and shorter than in a study of Frumiento C. et al. **[9]** (48 [15-130] minutes). The most concerned surgeries are inguinal hernia repair **[1, 2, 5, 7]**. But other surgeries (resection of ileostoma, sacral teratoma, …) can also be performed under SA **[11, 13]**.

The spinal puncture (2 [1 - 2] attempts) was performed in sitting or lateral position, in the intersection between the line connecting the highest point of both iliac crests (Tuffier’s line) and the vertebral axis, with an 80mm – G25 Quincke spinal needle. The midline approach on Tuffier’s line is the most used in SA in small children, in lateral or seated position **[6, 13, 16]**. A 25G pencil-point needle such Whitacre (avoiding post lumbar puncture headache) or 25G neonatal spinal needle are recommended **[11, 13]**. These types of needles are not available in the CHU JRA, so 25G Quincke spinal needle was used for all patients.

Hyperbaric bupivacaine 0.5% was used with a dose of 4 [3.5 - 4] mg. The most commonly used local anesthetics are tetracaine 0.5% and bupivacaine 0.5% lasting 90 to 120 minutes **[1]**. Hyperbaric bupivacaine (0.5%) is mostly used in a dose from 0.3 mg/kg to 1 mg/kg **[1, 6, 13, 17]**.

In the present study, for all the patients, 2 anesthetists who had prior training in this technique performed SA for limiting the bias in performance. Even the spinal anesthesia can be performed by either an anesthetist-intensivist, or an anesthesia-intensivist trainee, or a state-certified nurse anesthetist, SA performer should be well trained for the technique **[11]**. Trainees in anesthesia have a significant different success rate compared to anesthesiologists (83% *versus* 98.9%); the failure rate is 28% and the risk of total spinal anesthesia is approximately 0.63 to 0.8%, if the performer is not trained **[1, 5]**.

The success of the lumbar puncture was 97.1% after 2 [1 - 2] attempts and SA success was 94.2%. Since the Bromage score is not assessable in this pediatric population, the success of the spinal anesthesia is estimated and based on sudden loss of leg movement while normal tonus in the arms and/or the relaxation of the anal sphincter and the possibility of performing the surgical procedure **[14, 18]**. Williams R.K. et al. **[5]** reported a success rate of 97.4%, quite similar with our results. In the present study, no complementary local anesthesia by the surgeon was required and the GA conversion was 5.8%. This failure rate was similar to literature, varying from 1.04% to 24.6% **[7, 9, 17, 19]**. Dohms K. et al. **[19]** find a failure rate of 7.5% and 16% required supplemental anesthesia, also more than two punctures were needed in 28%. In Kachko L.'s **[7]** study, conversion to general anesthesia was 1.04%. In inguinal hernia repair, Frumiento C. et al. **[9]** describe 91.4% of adequate spinal anesthesia, 78,6% no supplemental anesthesia, 4.5% complementary local anesthesia and 2.2% general anesthesia conversion.

The heart rates were stable throughout perioperative period. Spinal anesthesia allows remarkable cardiovascular stability and can avoid bradycardia with minimum cardiac complications **[2, 8, 10, 14, 15, 18]**. But in some cases, 1.5% patients experienced bradycardia in operating room, and 1.9% received vagolytics **[9]**.

Spinal anesthesia offers a good balance between safety and perioperative risks and appears to be a safe technique, provided that the contraindications are respected; the frequency of complications is 30% **[1, 5, 10, 15]**. SA causes less bradycardia, apnea, desaturation, requiring postoperative respiratory assistance than GA; ventilation and oxygenation are not generally compromised, even in patients at high risk **[8, 18, 20]**. In the present study, no perioperative complications were observed.

In Antananarivo, this series is the first to have been reported. The strength in the present study is the characteristics of the study population (preterms, newborns, infants).

Conclusion

Spinal anesthesia can be performed in small pediatric patients, even in very young and very low-weight patient. Hernia repair surgery was the most concerned surgery under spinal anesthesia which had high success rate and no consequent complications. These first cases should motivate a wider and more frequent practice in Antananarivo, Madagascar.

LIMITATIONS

The monocentric and retrospective characteristic of this study are the main limits; 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 the spinal anesthesia was approved by the CHUJRA and head department
- The parents of anesthetized patients were informed of the SA and gave their consent before the realization of the surgical and anesthesia procedure

Availability of data and materials: Data and materials are available (excel)

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Consent for publication: all the authors consent for publication, all patients'data were anonymously analyzed

Competing interests: The authors have no conflict of interest

Author's contributions:

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

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Tables

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.*

Table 2: Perioperative characteristics

			n	%
Surgery	***Hernia (inguinal and/or scrotal) +/- circumcision***		50	72.5
		- bilateral hernia	*26*	*37.7*
		- right hernia	*16*	*23.2*
		- left hernia	*8*	*11.6*
	Bilateral ovarian hernia		19	27.5
	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 LA	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.*

Figures

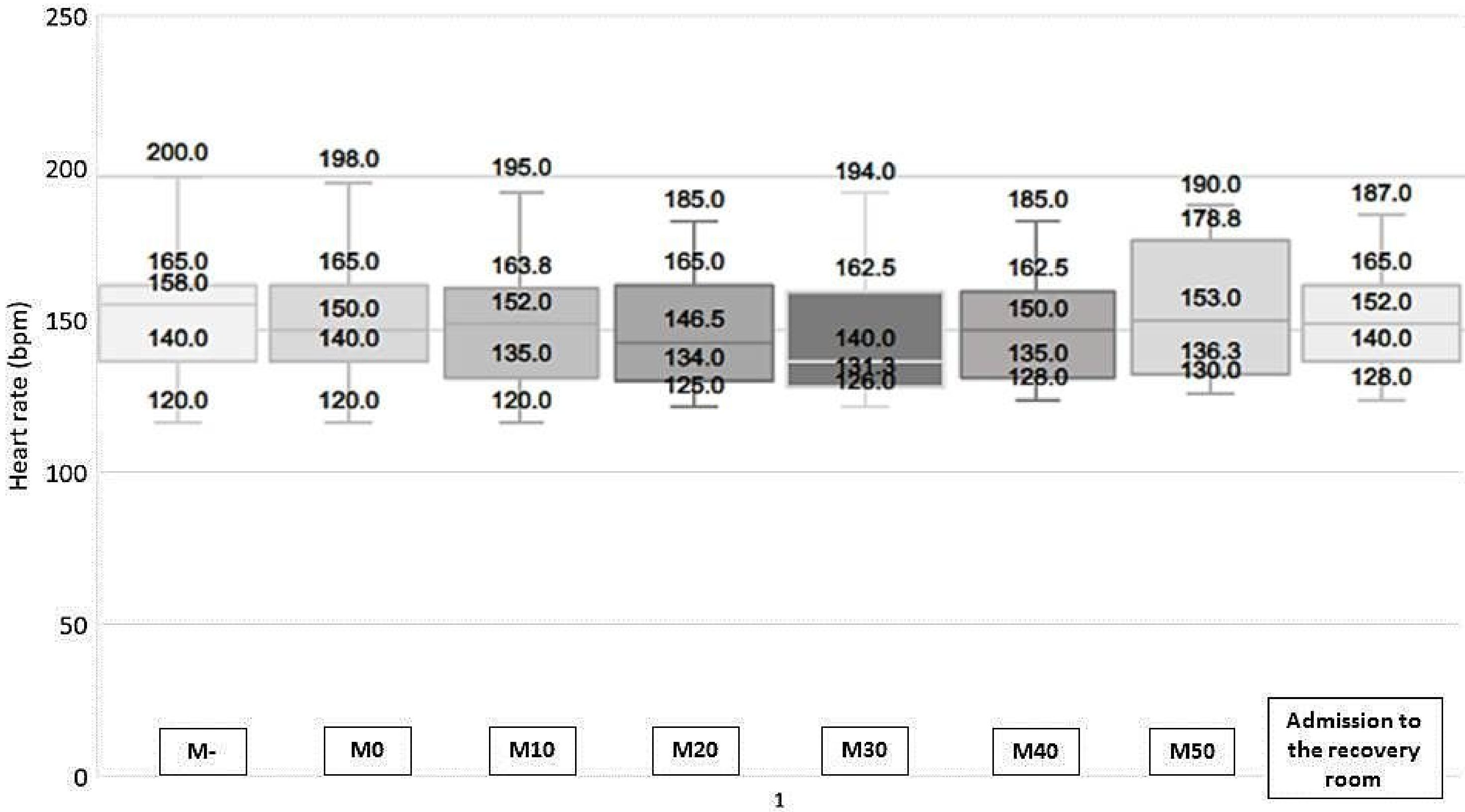

Figure 1

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