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Research Paper

Failed Spinal Anesthesia Status in Cesarean Section; A Report from a Teaching

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ABSTRACT

Background: The incidence of failed spinal anesthesia (FSA) for cesarean section (CS) varies widely among hospitals. Several risk factors have been proposed, but their predictive value remains unknown.

Objectives: The main objective of this prospective study was to evaluate the incidence of FSA for cesarean deliveries in an academic obstetric hospital, and the secondary objective was to determine its predictive factors.

Materials & Methods: This analytic descriptive study was performed in a referral obstetric hospital affiliated with Guilan University of Medical Sciences from May 2024 to August 2024. The study enrolled women who underwent elective and emergency CS under spinal anesthesia, classification of The American Society of Anesthesiologists (ASA-I and ASA-II). A checklist containing women's demographic data, surgery characteristics, and FSA rate was completed.

Results: A total of 241 women with a Mean±SD age of 29.54±6.64 years and body mass index (BMI) of 27.98±3.16 kg/m^2 participated. About 46 women (19.1%) underwent emergency CS and 195(80.9%) elective. Overall, the incidence of FSA was 7.9%. Of 19 FSA cases, 12(5%) received supplemental analgesia or sedation; in 5(2.1%) cases, the procedure was repeated, and only two cases underwent general anesthesia (GA). The most important predictive factors of FSA were BMI (P=0.003), emergency CS (P=0.0001), level of residency (P=0.037), bloody cerebrospinal fluid (P=0.0001), the number of attempts (P=0.0001), and ASA class (P=0.035).

Conclusion: In 7.9% of women, spinal anesthesia did not provide appropriate conditions for CS. Significant predictors included higher BMI, emergency surgeries, level of anesthesia residency, bloody CSF, the number of attempts, and ASA class.

Keywords: Spinal anesthesia, Cesarean section, Failure, Factors

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Highlights

• The rate of failed spinal anesthesia was acceptable compared to the average rate reported by other academic centers.

• Higher body mass index, emergency cesarean section, lower level of residency, bloody cerebrospinal fluid (CSF), the number of attempts and The American Society of Anesthesiologists (ASA) class were determined as predictive factors of failed spinal anesthesia.

Introduction

In Iran, the rate of cesarean section (CS) has been reported to be 21%, and in teaching hospitals, about 98% of cesarean deliveries are performed under spinal anesthesia (SA). The rate of general anesthesia (GA) for CS has decreased worldwide. However, the choice of anesthesia method varies according to the characteristics and facilities of hospitals [1]. SA is the anesthesia technique of choice for CS due to several advantages, including ease of the method, rapid onset, reliability, creation of optimal surgical conditions, less postoperative pain, infection, and intraoperative bleeding [2]. Despite the benefits mentioned, the issue of failed SA (FSA) is very challenging because both mother and baby may be exposed to unsafe conditions. Decreased maternal satisfaction, inadequate pain control, the need for additional medications, fetal distress, and inappropriate surgical conditions may occur. FSA can seriously challenge the anesthesiologist and is directly associated with maternal mortality [3, 4]. Studies have shown that FSA and the need to convert the technique to GA are among the causes of maternal mortality [5]. FSA can be partial or complete and has been reported in a wide range from 1% to 17%. The failure is multifactorial and can be related to anesthesiologist, patient, or equipment [3]. Studies show that, history of previous SA, higher body mass index (BMI), bloody cerebrospinal fluid (CSF), dose of local anesthetics, multiple punctures, less experience, lower birth weight, gestational age, fetal distress, maternal co-morbidities, duration of surgery were significantly associated with FSA [6-9]. To our knowledge, no previous study in Guilan Province, Iran has investigated this topic. In addition, due to the different conditions in each hospital and various influential factors, findings of other studies could not be generalized. Therefore, this study was planned in an academic and referral center in northern Iran to investigate the incidence of FSA and its associated factors.

Materials and Methods

The inclusion criteria included women above 18 who underwent elective (both mother and fetus were in stable and safe conditions and were candidates for CS due to other reasons such as previous CS or breach position) or emergency CS under SA, classification of The American Society of Anesthesiologists (ASA I and ASA II).

The exclusion criteria included women who disagreed to participate and developed high or total FSA. They were divided into two types: Complete failure, i.e. absence of sensory or motor blockade and partial failure when supplemental medications were required. In other words, if an adequate block was not achieved within 20 min after successful intrathecal bupivacaine administration and the inability to access the subarachnoid space during lumbar puncture, it was considered FSA [10].

The dependent variable was FSA (yes or no), and independent variables were sociodemographic characteristics, including age, BMI, obstetric-related factors; gestational age and anesthesia-related factors; ASA status; level of anesthesia residency; number of attempts and the appearance of CSF.

Method of anesthesia

Entering the operating room, standard monitoring, including oxygen saturation (SPO_2), electrocardiogram (ECG), heart rate (HR) and non-invasive blood pressure (NIBP) were performed and an 18-gauge intravenous cannula was inserted. Hydration with 10 mL/kg of ringer lactate was started and before the procedure, sufficient information was provided to the mother, and her informed consent was obtained. In a sitting position, SA was performed by placing a 25-gauge quincke needle between the lumbar vertebrae at L_3-L_4 or L_4-L_5 levels and through the dura to inject 12.5 mg isobar bupivacaine. The acceptable level of sensory blockade was T_4-T_6, evaluated using the 'pin-prick' test. The desired motor blockade level was scale 3, assessed according to the Bromage scale, using a 0 to 3 score according to the ability to move the lower ex-

tremities (0=no motor block, 1=able to move knees and feet but unable to raise extended legs, 2=able to move feet but unable to raise extended legs and move knees and 3=complete motor block) [11]. The mother received supplemental oxygen in the supine position by a simple facemask at 5 L/min. In resistant shivering after warming the mother, pethidine 25 mg IV was administrated after clamping the umbilical cord. If HR was lower than 50 bpm, atropine 0.5 mg IV was injected, and in case of hypotension, a bolus dose of ephedrine, 5-10 mg IV, was considered. If ephedrine 5 mg IV was administrated and blood pressure dropped below 20% from baseline or systolic blood pressure was less than 100 mm Hg, metoclopramide 10 mg IV was administered if the patient complained of nausea and vomiting. Safe discharge criteria are as follows: Mother should be awake, well-oriented, with stable vital signs, well-controlled postoperative nausea/vomiting and pain and be able to walk without dizziness [12].

Statistical analysis

Results were expressed as frequency (percentage) for categorical data, or as Mean±SD, or median for continuous data. The chi-square, the Mann Whitney U and Fisher exact tests were also used. Statistical analyses were performed using SPSS software, version 22.

Sample size calculation

Based on the study of Halimi et al. [13], with an estimate of the frequency of FSA at 6%, accepting the difference of 3% and considering the 95% confidence interval (CI), the desired sample size was calculated as 241.

Results

During the study, 255 women were screened for eligibility; 8 disagreed to participate and 5 were excluded due to communication difficulties. Two cases developed high SA, defined as a spread of local anesthetic to spinal nerves above T4 and were affected by cardiovascular and respiratory compromise. Finally, 241 eligible women completed the survey. Table 1 presents the values of age, ASA classification, BMI, CS status, number of gravidae, and gestational age.

The optimal dermatome block level was achieved in 92.1% of women. Most participants 151(58.15) had a successful block on the first attempt; in 78(32.4%), it was repeated twice, and in 23(9.5%), it was performed three or more times (Table 2). As Table 3 presents, a significant association was observed between the occurrence of FSA and BMI (P=0.003), emergency CS (P=0.0001), level of anesthesia residency (P=0.037), bloody CSF (P=0.0001), the number of attempts (P=0.0001), gestational age (P=0.103) and ASA class (P=0.035).

Discussion

Monitoring the quality of services and maternal safety is an important and ongoing process. For this reason, the success rate of SA should be regularly evaluated, and efforts should be made to improve the quality of the method [14]. A recent study at an academic center investigated the state of FSA in various surgeries. The results showed that the highest failure rate was related to CS [15]. Based on the results of this study, the FSA rate was reported to be 7.9%, which was lower than the results of similar studies in academic hospitals but higher than recommended by the Royal College of Anesthetists [16]. One of the cases recorded as FSA at this center was related to changing the spinal needle brand, which was used to test the quality of the new needle. A 31-year-old woman without underlying diseases, with a BMI in the normal range, was selected for this test, which resulted in FSA. In this study, only two emergency CS with fetal distress who were non-cooperative needed to convert to GA, which is equivalent to 0.8%. As SA to GA conversion is associated with maternal mortality, it was a valuable result [3]. Some studies have investigated the rate of FSA in specific conditions. In an academic hospital in Turkey, 251 confirmed COVID-19 CS were enrolled under SA. Despite the high difficulty in wearing personal protective equipment and concerns about contamination, a failure rate of 5.8% was reported [17]. In a retrospective cohort study in an academic and referral center, the status of FSA was assessed over 9 years. The results showed that 2.1% had FSA and 0.7% required GA [18]. In the present study, a significant association was found between FSA and emergency CS, supported by Stav et al. They reported that 1.7% of women undergoing CS under SA required conversion to GA, and 4.1% of them received supplemental analgesics/sedatives medications. Bupivacaine dose, surgical duration, emergency CS, and postpartum hemorrhage were significant predictors of the need for conversion to GA [19]. In emergency CS, stressful conditions can negatively impact the performance of the anesthesiologist. Since the mother is transferred from labor to the operating room in a stressful situation, worried about the neonate, and often after an unsuccessful and painful labor induction, her cooperation with the method is reduced. On the other hand, the obstetrics surgeon may start the surgical incision before establishing adequate

Table 1. Sociodemographic and obstetric characteristics of women who underwent cesarean section under spinal anesthesia

Variables	Category	No. (%)/Mean±SD
Age (y)	≥30	139(57.7)
	<30	102(42.3)
	-	29.54±6.64
BMI (kg/m^2)	≥30	162(67.2)
	<30	79(32.8)
	-	27.98±3.16
ASA class	I	190(78.8)
	II	51(21.2)
Gestational age (wk)	≥36	15(6.2)
	<36	226(93.8)
	-	37.75±1.36
Gravidity	1	121(50.2)
	2	68(28.2)
	3	38(15.8)
	>3	14(5.8)
	-	1.77±0.91
CS status	Emergency	46(19.1)
	Elective	195(80.9)

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Abbreviations: BMI: Body mass index; CS: Cesarean section; ASA class: The American Society of Anesthesiologists class.

anesthesia due to the concern about fetal distress. In terms of high BMI, similar to us, Bekele et al. reported that BMI≥30 kg/m^2 was a risk factor for FSA [20] which was consistent with the study of A. Alabi et al. [6], while it was inconsistent with the study of Rukewe et al. [9]. The possible reason can be due to the anatomical challenges in accessing the intervertebral space and the difficulty of the technique [7]. However, some studies reported no problems in performing SA in obese pregnant women [21]. In the present study, more than one attempt was associated with the FSA, which was in accordance with the study of Bekele et al. [20]. However, contrary to Rukewe et al. study [9], in Ashagri et al. study from a teaching hospital in Ethiopia, 19.6% of women experienced FSA [8]. A review of the literature reveals a wide variation in the results. Different studies have proposed different rates of FSA and various associated factors. Of course, the main reason for this inconsistency is the difference in the methods, the studied populations, and the inclusion and exclusion criteria [22]. For example, in the study of Sng et al. [10], only elective CS was included, while in Beke's study, as well as in the present study, all elective and emergency cases were enrolled [8, 20]. The characteristics of the hospitals are also important. Obviously, in a teaching and referral hospital like ours, where high-risk CS from the whole province and residents are in training, the results are different from those in the private sector, where specialists perform all the procedures. In Bekele's study, university centers were not included [20]. The other influential factor is the surgeon's experience. Less skill results in longer procedures, which may reduce the effect of anesthesia [23] and the surgical manipulations are wider than the uterus. Different definitions of FSA might also explain this wide range of results, including the need for adjunctive medication or inadequate/absent block. Indeed, studies have not used a

Table 2. Anesthesia-related factors of mothers who underwent cesarean section under spinal anesthesia

Variables		No. (%)
ASA class	ASA I	190(78.8)
	ASAII	51(21.2)
Level of residency (y)	2	98(40.7)
	3	97(40.2)
	4	46(19.1)
Appearance of CSF	Clear	222(92.1)
	Bloody	19(7.9)
Spinal block status	Successful	222(92.1)
	Failed	19(7.9)
Number of attempts	1	140(58.1)
	2	78(32.4)
	3	10(4.1)
	4	13(5.4)

CSF: Cerebrospinal fluid; ASA class: The American Society of Anesthesiologists class.

comprehensive and common definition [10]. For example, a study reported a failure rate of 2.1%, while 4.1% of women had pain during surgery, and SA did not provide complete analgesia for them. In the present study, any case that required sedation and analgesia was considered failure. Previous CS, concomitant tubal ligation, BMI, and longer surgery duration were known as predictors of FSA [18]. On the other hand, it should be noted that pain expression is subjective, and it cannot be denied that individual's pain tolerance threshold varies from person to person. In another study from Colombia in an academic center, it was reported that of 399 CS under SA, 46 cases (11.5%) experienced some degree of pain during surgery and 16(34.8%) received ketamine, dexmedetomidine, and midazolam. In 3 cases (6.5%), GA was performed due to severe maternal anxiety and agitation. They found maternal addiction and longer surgery as predisposing factors [24]. This issue is also one of the differences between the studied populations. In the present study, patients who had addiction or mental problems as well as complicated surgeries with longer than expected duration were excluded. In a study conducted at an academic hospital in Canada, it was reported that during CS, women complained of painless sensation of stretching and surgical irritations that was not considered FSA. However, it was distressing and mothers believed that, they should have been informed about intraoperative intense tractions [25].

Conclusion

Based on the results of this study, the incidence of FSA in CS was acceptable compared to other academic centers; however, it was not according to the standards of the Royal College of Anesthetists. Although these findings partly indicate that the residency training system in Al-Zahra Hospital, as well as the attending supervision on their performance, are in favorable condition, considering the importance of the issue and being an academic and referral center, it is necessary to develop strategies to minimize these cases by being aware of the current situation and factors associated with this event.

Study limitations

It was a single-center study, and only the residents' performance was evaluated. Moreover, non-educational private or government centers were not included in the study.

Table 3. The association between fsa and study variables

Variables		No. (%)/Mean±SD		P
		Successful	Failed	
Age (y)	≥30	131(94.2)	8(5.8)	0.152
	<30	91(89.2)	11(10.8)	
	-	29.31±6.53	32.21±7.5	0.101
BMI (kg/m²)	≥30	154(95.1)	8(4.9)	0.015
	<30	68(86.1)	11(13.9)	
	-	27.81±3.2	30.01±1.76	0.003*
ASA Class	I	179(94.2)	11(5.8)	0.035*
	II	43(84.3)	8(15.7)	
Gestational age (wk)	≥36	12(80)	3(20)	0.103
	<36	210(92.9)	16(7.1)	
	-	37.74±1.3	37.84±1.97	0.64
Gravidity	1	111(91.7)	10(8.3)	0.672
	2	64(94.1)	4(5.9)	
	3	35(92.1)	3(7.9)	
	>3	12(85.7)	2(14.3)	
	-	1.76±0.9	1.84±1.06	0.918
Classification	Emegency	32(69.6)	14(30.4)	0.0001*
	Elective	190(97.4)	5(2.6)	
Number of attempts to perform spinal anesthesia	1	140(100)	0	0.0001*
	2	75(96.2)	3(3.8)	
	3	4(40)	6(60)	
	4	3(23.1)	10(76.9)	
Appearance of CSF	Clear	217(97.7)	5(2.3)	0.0001*
	Bloody	5(26.3)	14(73.7)	
Level of residency (y)	2	85(86.7)	13(13.3)	0.037*
	3	93(95.9)	4(4.1)	
	4	44(95.7)	2(4.3)	

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Abbreviations: BMI: Body mass index; CS: Cesarean section; ASA class: The American Society of Anesthesiologists class; CSF: Cerebrospinal fluid.

*P<0.05.

Study suggestions

Given the importance of this topic, it is recommended that the private sector be examined, where specialists perform SA procedures. This way, the conditions in private and teaching hospitals can be compared.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Ethics Committee of Guilan University of Medical Sciences (Code: IR.GUMS.REC.1403.062). Informed consent was obtained from the participants.

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Authors contributions

Conceptualization, writing, review and editing: Gelareh Biazar and Fatemeh Hosseinzadeh; Resources: Arezoo Mansouri and Fatemeh Hosseinzadeh; Writing original draft preparation: Gelareh Biazar and Arezoo Mansouri; Methodology: Soheil Soltanipour; Supervision: Fatemeh Hosseinzadeh and Zahra Rafiei Sorouri.

Conflict of interest

The authors declared no conflict of interest.

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