ADDIS ABABA UNIVERSITY

COLLEGE OF HEALTH SCIENCE

DEPARTMENT OF ANESTHESIA

Magnitude and associated factors of failed spinal anesthesia in cesarean section at Addis Ababa governmental hospitals, Ethiopia.

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A thesis submitted to the department of anesthesia, college of health sciences, Addis Ababa University in partial fulfillment for the requirement of the master degree in anesthesia.

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Background: Nowadays use of spinal anesthesia is the preferred anesthesia technique for cesarean section because it avoids air way related complication. But sometimes failed spinal anesthesia occurred and expose patient for pain and discomfort.

Objective: To assess magnitude and associated factors of failed spinal anesthesia in a mother underwent cesarean section at Addis Ababa governmental hospitals, Ethiopia from December 2018- May 2019.

Methods: An institutional based cross sectional study was conducted on 794 mothers who fulfilled inclusion criteria for elective and emergency cesarean section under spinal anesthesia at selected Addis Ababa governmental hospitals, Ethiopia from December 2018 – May 2019. Data collection methods include patient interview, chart review and observation of spinal anesthesia procedure were employed for data collection. Collected data were entered in Epi info version 7 and analyzed using SPSS version 20. Independent variables with the dependent variable were analyzed using logistic regression. A p-value of <0.05 was considered as cutoff point to test for statistically significant.

Result: Magnitude of failed spinal anesthesia in this study was 15.2% (121/794). Experience of the anesthetist <1 (AOR 4.12, 95%CI, 2.47-6.90), patient position (AOR=14.43,95%CL; 2.65-78.61) number of attempt > 1 (AOR;=9.26 , 95% CI; 5.69-15.01), bloody CSF (AOR=6.37, 95%CI; 2.90-13.96), BMI ≥30kgm^2 (AOR=2.03, 95%CI; 1.12-3.68) and dose of bupivacaine < 10mg (AOR; 2.72, 95% CI; 1.33-5.53) were significantly contributed for failed spinal anesthesia in this study.

Conclusion and recommendation: Magnitude of failed spinal anesthesia in Addis Ababa governmental hospitals was high. Anesthesia professionals should know all possible factors and develop strategy to overcome the problem, and use of adjuvants should be a daily practice for anesthetist.

Keywords: Failed spinal anesthesia, cesarean section.

Certification

The under signed certify that the research entitled assessment of magnitude and associated factors of failed spinal anesthesia in cesarean section at Addis Ababa governmental hospita, Ethiopia Institutional based prospective cross sectional study is my original work and any literature and/or data cited in this article were listed in the reference section and any assist done during this period has been given an acknowledgement.

Investigators

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Approval of the Board of Examiners

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Abbreviations and Acronyms

ASA: American Society of Anesthesiologists

BMI: Body Mass Index

BSC: Bachelor degree in anesthesia

CS: Cesarean section

CSF: Cerebrospinal fluid

ETB: Ethiopian Birr

GA: General Anesthesia

MSC: Master degree in anesthesia

OR: Operation Room

PGY-2: Post graduate year two

SA: Spinal Anesthesia

SPSS; Statistical Package for Social Sciences

UGY-4; under graduate year four

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Chapter one: Introduction

1.1. Background

There is an increasing Caesarean section rate worldwide and spinal anesthesia is the anesthetic choice for this operative procedure. Spinal anesthesia is done by injection of local anesthesia in the cerebrospinal fluid with spinal needle without need of airway management(1,2). Spinal anesthesia is low-cost for a patient, reliable for set up, fast onset block even in emergency and it evade complication of general anesthesia for instance aspiration, failed tracheal intubation, decrease bleeding, decrease the tendency of postoperative pulmonary embolism or deep Venus thrombosis, decrease baby drug toxicity, increase patient pleasure and it is easy to learn and perform (3,4).

Despite the above advantage sometimes failed spinal occur. Failed spinal anesthesia can be partial or complete. A bupivacaine spinal anesthetic is considered to ensure failed, if anesthesia and analgesia have not been obtained within ten minutes of heavy bupivacaine and 25 minutes of isobaric bupivacaine after successful intrathecal deposition of the drug. Complete failure was defined as no sensory or motor blockade and partial failure was defined as inadequate extent, quality or duration of drug action for that surgery(3)(4). Our definition of failed spinal anesthesia also included preoperative failure to achieve a pain-free operative condition for example lumbar puncture was attempted but the subarachnoid space was not found (5).

A level of anesthesia up to and including T5 is required to prevent pain during caesarean section (6) Assessments of block height rely on the personal experience and perceptions of the patient, and the relationship between block height as assessed by touch, pinprick or cold (7). Magnitude of failed spinal anesthesia in current literature ranges 0.5% to 6% and old literature reported incidence of failed spinal anesthesia between 1% to 17% (4.7). But magnitude of failed spinal anesthesia in the training environment could be as high as 25% (8).

The attainment of spinal anesthesia depends on the experience of the anesthesia provider. Many studies reported obesity as an independent predictor of FSA, while others obesity was not predictor for failed spinal anesthesia and study reported factors associated with failed spinal anesthesia are bloody appearance of CSF, emergency cesarean section, multiple attempt, dose of

bupivacaine, duration of surgery, previous anesthesia history, spinal needle type and size and baricty of bupivacaine (7,8,9,10, 11).

1.2: Statement of problem

Data on magnitude and associated factor of failed spinal conversion of spinal anesthesia for CS anesthesia comes from developed countries. Diversity in patient populations and anesthesia practices of different countries tend to challenge these comparisons. It is important to review data from developing countries to review the failure rate of spinal anesthesia. Spinal anesthesia for cesarean section is not a 100% effective procedure. At times, although straight forward insertion and drug administration occur, intrathecal anesthesia for cesarean section fails to get any sensory or motor block(10).

A different factor has been implicated in failure of spinal block including: failure of lumbar puncture, in appropriate preparation and injection of solutions, inadequate spread of drugs through CSF, failure of drug action on nerve tissue, difficulties more related to patient, movement of the needle during injection and technical errors(16). There is no data indicating the magnitude and associated factors of failed spinal anesthesia. So, the result of this research will help us to determine the magnitude and associated risk factors which can lead to the poor technique of spinal anesthesia in Addis Ababa governmental hospitals.

1.3: Significance of the study

It has been shown by different researchers that failed spinal anesthesia will result in pain and distress during operation(12,13). And if complete failure happen we are forced to change into general anesthesia; this may results for air way complication like difficult intubation and aspiration (6). But those problems in Addis Ababa governmental hospitals were mistreated.

Failed spinal has serious medical and medico legal issue (12). And it may leave mothers with poor impression of maternal wellbeing under spinal anesthesia and this may affect subsequent anesthetic decisions (13). Therefore conducting a study on magnitude and associated factors will help you reduce the problem associated with failed spinal anesthesia.

.It will be used as a source of information for institution and individuals who are interested to do further study about this technique. So, the technique must be conducted in a way which minimizes the risk of regional block. Thus, practitioners must be aware of all the possible mechanisms of failure so that, where possible these mechanisms can be avoided. The identification of these risk factors for the block failure could help anesthetist to develop strategies to overcome this problem.

Chapter two: Literature review

2.1 Failed spinal anesthesia

Definition failed spinal anesthesia different across studies. British journal of anesthesia 2009 describe failed spinal anesthesia as inadequate level, quality or duration of local anesthetic (12). Study done by Hridoy Kumar et al. defined failed spinal anesthesia as unable to obtain CSF sometimes referred to as a 'dry tap' (14). Assessment of block height by the anesthetist is implemented by touch, pinprick and cold perception (7). And height of sensory block needed for cesarean section is T4 level (15). Definition of failed spinal anesthesia was based on bupivacaine anesthesia in this study hence onset of action of different local anesthetic agent is different and bupivacaine is one of well-studied local anesthetic agent (8).

2.2 Magnitude of failed spinal anesthesia

Most experienced practitioners reflected magnitude of failed spinal anesthesia was less than 1% (16,17, 18). However failure might reach 17% as quoted by American teaching hospital (9). Another research by Levy et al. a relatively high magnitude of failed spinal anesthesia 17% was reported, which was ascribed to the low level of experience of the provider of the anesthesia (17). Another research done in 2016 by Adesope et al. in UK, of 5015 mothers undergo cesarean section under spinal anesthesia failure rate was 5.5% (18).

Research done in 1998 by K.uwe reported incidence of failed spinal anesthesia was 5.1% from 394 parturient (19). Another observational cohort study in Singapore on 800 parturient four women had total failure Thirty-seven (4.6%) of these had partial failure of spinal anesthesia (16). And retrospective cohort study in Nepal done by Amir Babu, reported the total failure of spinal anesthesia was 6% of which 4,3% was converted to general anesthesia and 1.8% was managed by supplemental analgesia (20). And also another retrospective audit in UK from 1610 mothers taken spinal anesthesia 0.75% was converted to general anesthesia and 10.9% was done by supplemental analgesia (6).

Research by L.enihorn was reported rate of failed spinal 11 % from the 263 mothers underwent cesarean section under spinal anesthesia (21). Another study done in Nepal of the total number 6641 mother underwent cesarean section under spinal anesthesia, 9.9% required additional

anesthetic supplements. Conversion to general anesthesia was needed in (3.79%) patients. The rest 6.15% operated with administration of additional intravenous anesthetic agents (25).

In research done in kirtipur hospital (Nepal) of 660 women undergoing cesarean section the failure rate of spinal anesthesia was 1.66%. Among them complete failed spinal anesthesia was 0.075% requiring conversion to general anesthesia and 0.9% was required intraoperative supplemental (22), Another research done in India 42 patients out of a total number of 1673 developed partial or complete failure (3).

A cohort study in South Africa, incidence of failed spinal anesthesia out of 197 patients was 11.7% (n = 23) (23). Another study in 2015 in Nigeria teaching hospital incidence of overall failed spinal anesthesia was 9.1% from 3239 mothers And another Clinical research done in west Nigeria of 414 mothers underwent cesarean section under spinal anesthesia failed spinal anesthesia rate was 6.0% from this total failure intra-operative supplemental analgesic was required in 6.4% incidence rare to complete surgery(5)(13)

2.3 Associated factor of failed spinal anesthesia

Research done in 2016 by Adesope et al. in USA reported gestational age were contributing factor for failed spinal anesthesia in cesarean section (18). Another Research done by Broadbent et al. in UK reported that anesthetists cannot reliably identify a particular lumbar interspace by palpation. Accuracy is not improved by use of the sitting position rather by obesity (13). Another research done in 2009 by Bamgbade et al. was reported that obesity was significantly contributed for failed spinal anesthesia (24).

Research in 2009 by p.fettes et al. factors for failed spinal anesthesia in cesarean section considered to be among the three aspects: clinical technique, inexperience (of the unsupervised trainee especially), and failure to appreciate the need for a meticulous approach (12). And another Research in 1998 by K.uwe at republic of china reported that type of spinal needle were contributing factor for failed spinal anesthesia (25).

Research done in 2015 by Debasish et al. in India factor for failed spinal anesthesia could be inadequate dose of local anesthetic or loss of the drug from the junction of the needle and syringe may be other causes of failed block. Loss of potency of the drug due to prolonged exposure to light or high CSF alkalinity may result in failure of spinal anesthesia or in the case of ester type of local anesthetic the drug may be hydrolyzed by blood pseudo-cholinesterase when there is bloody tap (26). Research done in 2017 by Adeyinka et al. experience of anesthetist, multiple puncture, dose of bupivacaine, and level of drug administered were significantly associated with failed spinal anesthesia in cesarean section (23). Another Research done by Ružman T, et al. confirmed that Multiple skin punctures were associated with higher spinal failure rate (27).

2.4: Consequences of failed spinal anesthesia

Failed spinal anesthesia result serious clinical, psychological, and medico-legal consequences, especially if the failure becomes evident after starting the surgery (28).In the study done by Gynakol, Zentralb et al. failed spinal anesthesia exposed mothers for complication of general anesthesia like failed tracheal intubation, aspiration and exposing mothers and baby with multiple drug toxicity (29).

2.5: Prevention of failed spinal anesthesia

We can decrease magnitude of failed spinal anesthesia by correctly position patient, identifying correct land mark for needle insertion, appropriate dose of drug and by using adjuvant with local anesthetic agent (12).When dealing with inadequate spinal anesthesia, one must remain calm and appear to be in full control. Frequent testing may increase anxiety and result in loss of rapport (28).

Chapter Three: Objective

3.1 General objective

To assess the magnitude and associated factors of failed spinal anesthesia in cesarean section at Addis Ababa governmental hospitals, Addis Ababa, Ethiopia from December 2018-May2019

3.2 specific objectives

- To determine the magnitude of failed spinal anesthesia in mothers who underwent caesarean section under spinal anesthesia at Addis Ababa governmental hospitals.
- To identify factors associated with failed spinal anesthesia in mothers underwent cesarean section at Addis Ababa governmental hospitals.

Research questions

1. What is the proportion of failed spinal anesthesia among mothers who undergo a caesarean section under spinal anesthesia?
2. What are the predictors of failed spinal anesthesia?

Chapter four: Methodology

4.1 Study design and period

Institutional based cross sectional study was conducted at Addis Ababa governmental hospital, Ethiopia from December 2018-May 2019.

4.1 study area

The study was carried out at Addis Ababa governmental hospital, Ethiopia from December 2018-May 2019. Addis Ababa is the capital city of Ethiopia with a population of 3,475,952 according to the 2007 population census with altitudes ranging from 2200 to 3000 meter above sea level and average temperature of 22.8°C has 40 hospitals (twelve public and 28 private), 29 health's centers, 122 health stations, 37 health posts and 382 modern private clinics (30).

4.3 Source and study population

4.3.1 Source of population

All mothers who underwent elective and emergency cesarean section at Addis Ababa governmental hospitals.

4.3.2 Study population

Mothers who underwent elective and emergency cesarean section under spinal anesthesia that fulfilled the inclusive criteria at Addis Ababa governmental hospitals from December 2018- May 2019.

4.4 Eligibility criteria

4.4.1 Inclusion criteria

Selected ASA I and ASA II mothers that underwent scheduled and emergency cesarean section under spinal anesthesia from December 2018- May 2019 were included in the study.

4.4.2 Exclusive criteria

- Mothers who were contraindicated for spinal anesthesia such as: coagulopathy, local infection ,known allergy for local anesthetic and patient refusal
- Mothers who had combined spinal epidural (CSE) for labor analgesia.
- Mothers who developed intraoperative high or total spinal anesthesia

4.5 Variables

4.5.1 Dependent variable

Failed Spinal Anesthesia – Yes / No

4.5.2 Independent variable

- Socio demographic characteristics: Age, weight, height and BMI
- Obstetric related factor: Gestational age, classification of cesarean section.
- Anesthesia related factors: Previous anesthesia history, ASA status, anesthetist experience, patient position, spinal needle approach, type and size of spinal needle, numbers of attempt, appearance of CSF, dose and baricity of bupivacaine, adjuvant drug and level of drug administered.
- Surgical related factors: Duration of surgery and blood loss

4.12 Operational definition

- Preoperative failed spinal anesthesia: Defined as spinal anesthesia were attempted but unable get subarachnoid space or cerebrospinal fluid and no somatosensory block after injection of local anesthetic into cerebrospinal fluid with in ten minutes of hyperbaric bupivacaine and fifteen minutes of isobaric bupivacaine before surgical incision occur.
- Intraoperative failed spinal anesthesia: Defined as failure after incision has begun requiring either conversion to general anesthesia or supplemental analgesia to complete the surgery.
- Complete failed spinal anesthesia: No somatosensory block requiring either repeating spinal anesthesia or conversion to general anesthesia.
- Partial failed spinal anesthesia: Is defined as there is partial block but need supplemental analgesia to complete surgery.
- Undergraduate year four (UGY-4): Taken as experience having < 1 year
- Postgraduate year two (PGY-2): Taken as experience having > 1 year
- MSC anesthetist: Taken as experience having > 1 year
- BSC anesthetist: Based on their duration of experience taken as either experience having < 1 year or ≥ 1 year.
- Failed spinal anesthesia in this study decided to be failed when seniors fail to perform the procedure and it was not for purpose of research rather it is usual trained in Addis Ababa governmental hospital.

Sample size and sampling techniques

4.6.1 Sample size calculation

Sample size estimate based on previous study proportion of failed spinal anesthesia (9.1%) in cesarean section 2015 by Rukew Nigeria (5). A single proportion formula with proportion of failed spinal anesthesia 9.1%, 95% confidence level and α=5%. Research done by Pourhoseingholi *e*t al. sample size calculation for medical studies reported appropriate precision was determined by taking one fourth or one fifth of proportion (P) therefore d=2% (31). By using single proportion formula our total sample size would be

$$n= \frac{(Z\alpha/2)^2 P(1-P)}{d^2}$$, where α=5%, P=9.1%=0.091, Q=1-P=90.9%=0.909 and d=0.02

$$n= \frac{(1.96)^2 (0.091)(0.909)}{(0.02)^2} = 794$$

4.6.2 Sampling technique

Out of twelve Addis Ababa governmental hospitals, five hospitals were selected by lottery method. Depending upon average values of the previous surgery per three and half month on the log book 1225 mothers underwent elective and emergency cesarean section at selected Addis Ababa governmental hospitals. Then parturient who underwent cesarean section under spinal anesthesia was proportionally allocated for each selected Addis Ababa governmental hospitals.

The study unit were determined from 1225 mothers estimated to undergo emergency and elective cesarean section under spinal anesthesia in five hospitals during study period, 794 participants were recruited with the probability of about 65% by considering the consecutive emergency or elective cesarean section. Participant was selected by systemic random sampling where one number selected randomly and used as exclusion criteria then data collection were made on 2 mothers for every 3 mothers who underwent emergency and elective cesarean section made on the rest of numbers until the required sample size is reached.

4.6.3 Sampling procedure

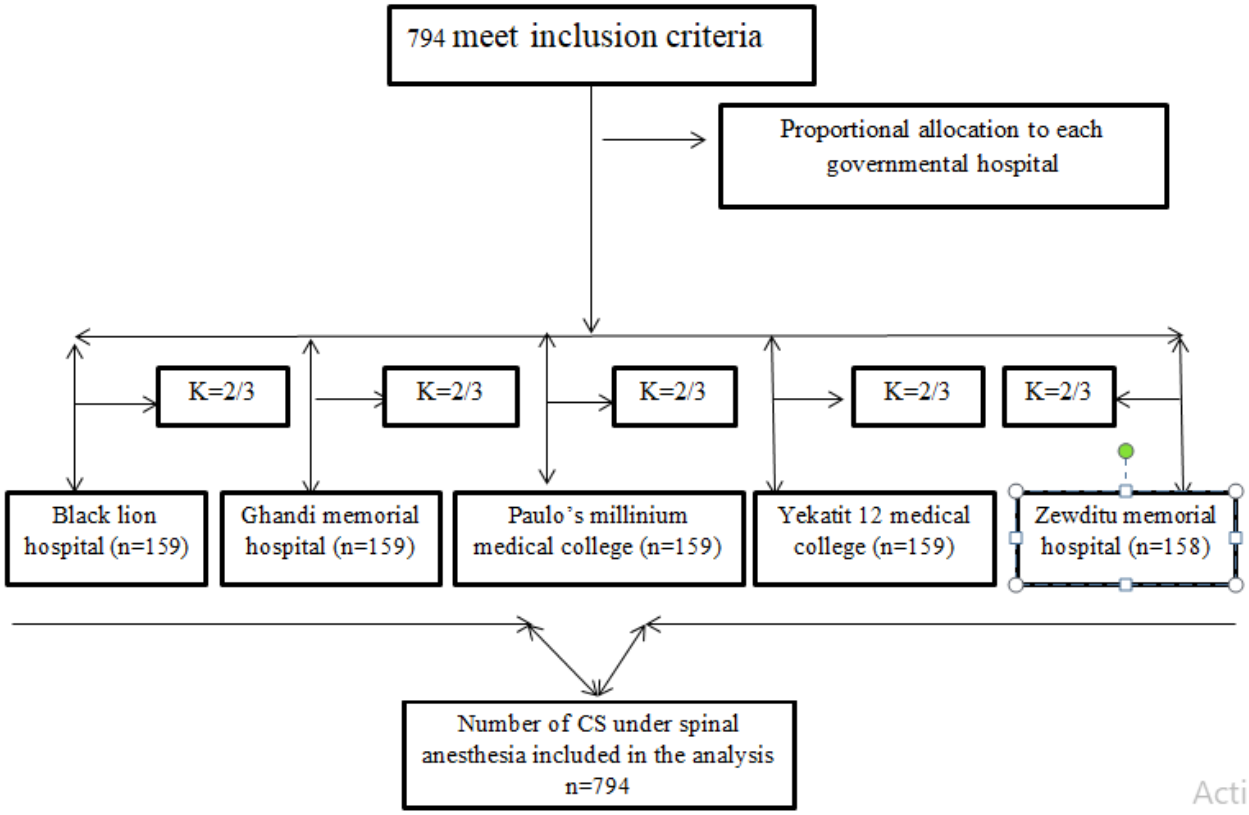

Figure 1: proportional allocation and enrollment chart for parturient underwent elective and emergency cesarean section for each selected Addis Ababa governmental hospitals, Ethiopia from December 2018- May 2019.

4.7 Data collection technique

Data collection procedure was done by patient interview, reviewing chart and observing the spinal anesthesia procedure. Demographic data collected were age, weight, height and BMI. Obstetric data including indication for Caesarean section, classification of surgery (elective or emergency), gestational age, and number of previous Caesarean sections were recorded. The anesthesia data collected were previous history of anesthesia, ASA status, position in which the spinal was performed, inter-vertebral space used, type and dose of bupivacaine injected, sensory block height determined by loss of cold sensation, motor grading, need for intravenous supplemental analgesia (e.g. ketamine, fentanyl and pethidine), need for conversion to general anesthesia or repeating spinal anesthesia and the status of the anesthetists and experience who

performed the spinal block. Surgical data collected were Duration of surgery, blood loss and status of surgeon.

4.8 Data quality control

To assure the reliability and validity of data, questionnaires were pretested on 5% of sample size before actual data collection. Training orientation about the objectives and relevance of the study was done by principal invigilator. Each items included in the study tools and the whole process of data collection were provided for data collectors and supervisors. During data collection, regular supervision and follow up were undertaken. A supervisor checked each questionnaire daily with further cross check by principal investigator for completeness and consistency of data. Incomplete data were not entered on data base prepared on Epi info. Data clean up and crosschecking of missing data was done before analysis on Excel and SPSS.

4.9 Data analysis and interpretation

The data were coded and entered in to Epi info version 7 and exported to SPSS version 20. Data were analyzed using SPSS version 20 window. All Independent variables with the dependent variable were analyzed using binary logistic regression. Odds ratio, 95% confidence interval, and p-value were computed to identify associated factors and to determine the strength of the association. Variables with p-value less than 0.2 on Bivariate logistic analysis were taken to multivariable logistic regression analysis and a p-value of <0.05 was considered as cutoff point to test for statistically significant. The distribution normality of each variable was analyzed in the Shapiro-wilk test.

4.10 Ethical consideration

Ethical clearance was obtained from the department ethical clearance committee before the start of the study. Official support letter was written to each selected Addis Ababa governmental hospitals and permission for data collection was sought from the responsible authorities. The purposes and the importance of the study were explained and verbal as well as written informed consent was obtained from each participant. Confidentiality was maintained at all levels of the study by avoiding identifiers and using codes to identify patients. The participant's involvement in the study was on a voluntary basis, participants who are not willing to participate in the study.

4.11 Dissemination plan

The research will be presented for the entire department of anesthesia staff. It will also be presented at the annual anesthesia association conference. The research will be submitted to journals for publication.

Chapter five: Result

5.1 Socio demographic characteristic 794 mothers underwent cesarean section under spinal anesthesia at Addis Ababa governmental hospitals, Ethiopia from December 2018-May 2019.

From a sample of 794 mothers, all mothers were included in the study. The mean age of mothers was 28.39 ±5.873. With regard to BMI, the mean BMI of participant was 24.56±3.22 with Height and weight ranged from 1.50 -1.80 meters and 47 to 115 kilograms respectively.

Table 1: Socio demographic, obstetric and surgical characteristics of 794 mothers underwent emergency and elective cesarean section at selected Addis Ababa governmental hospitals, Ethiopia from December 2018-May 2019.

Variables		Frequency	(%)
Age	15-24	244	30.7
	25-34	410	51.6
	35-44	140	17.6
BMI	<18.5	59	0.6
	18.5-24.9	489	61.6
	25-34.9	218	27.5
	35-39.9	56	7.1
	±40	3	0.4
Classification of CS	Emergency	225	28.3
	Elective	569	71.7
Gestational age	<37weeks	184	23.2
	≥ 37 weeks	610	76.8
Mean ± SD	38.5 ± 1.471		
Duration of surgery	<45	708	9.2
	45-60	67	8.4
	>60	19	2.4
Blood loss	>1	72	9.1
	0.5-1	722	90.9

Table 2: Anesthetic related characteristic of 794 mothers underwent emergency and elective cesarean section at selected Addis Ababa governmental hospitals, Ethiopia from December 2018-May 2019.

Variables		Frequency	(%)
History of SA	Yes	268	33.8
	No	526	76.2
ASA status	ASA I	679	84.5
	ASAII	115	14.5
Experience of anesthetist	< 1year	328	41.3
	≥ 1year	466	58.7
Patient position	Sitting	785	98.9
	Lateral	9	1.1
Baricity bupivacaine	Hyperbaric	46	5.8
	Isobaric	748	94.2
Dose of bupivacaine	< 10mg	84	10.6
	≥ 10mg	710	89.4
Appearance of CSF	Clear	751	94.6
	Bloody	43	5.4
Spinal needle	≥ 24gauge	175	22
	< 23 gauge	619	78
Adjuvant	Yes	121	15.2
	No	673	84.8
Intervertebral space	L2-L3	7	0.9
	L3-L4	758	95.5
	L4-L5	29	3.7

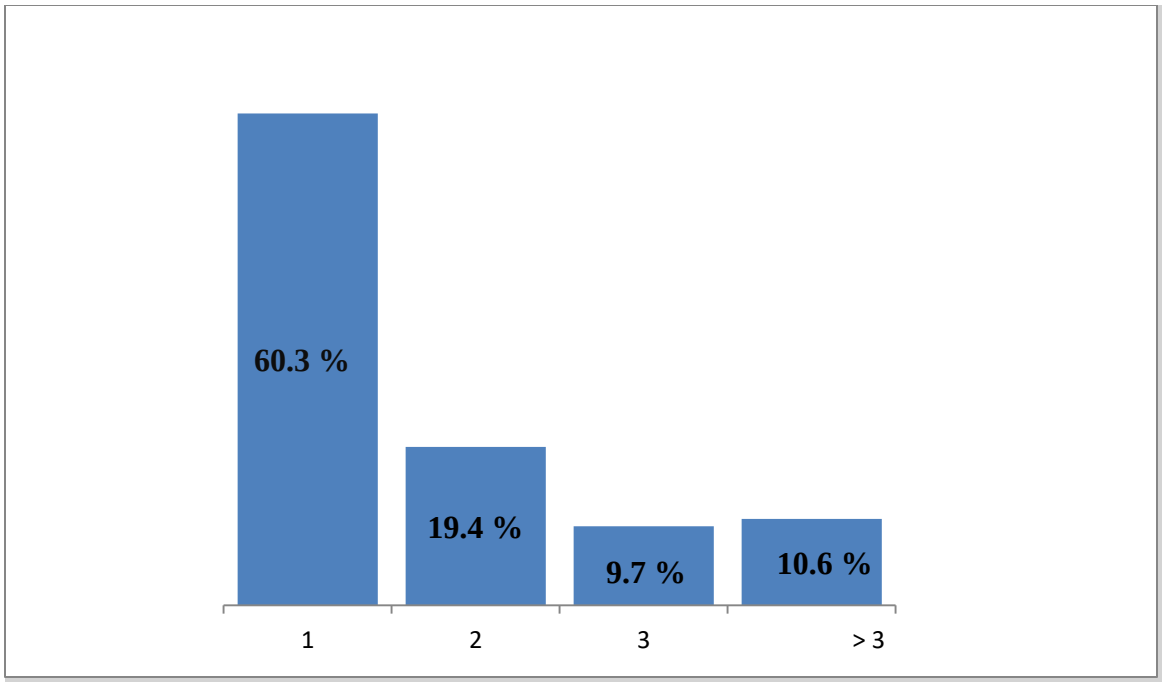

Figure 2: Numbers of attempts during the procedure at selected governmental hospital Ethiopia from December 2018-May 2019.

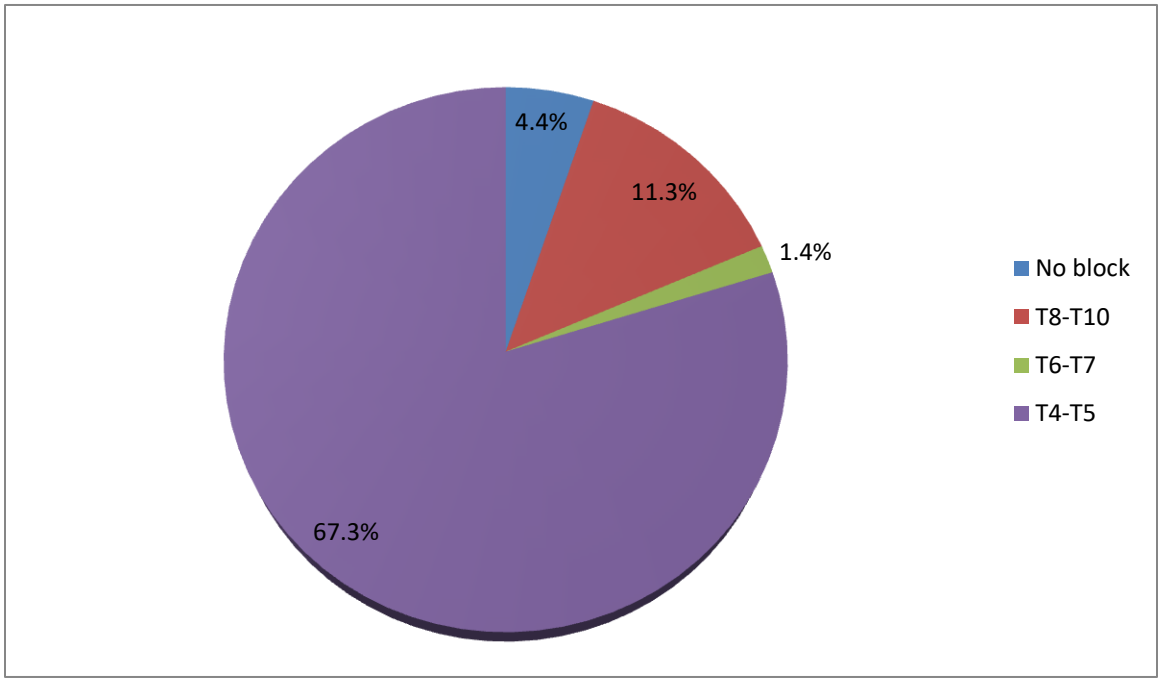

Figure 2 Height of sensory block after spinal for cesarean section at selected governmental hospitals, Ethiopia from December 2018-May 2019.

5.4 Magnitude of failed spinal anesthesia in 794 mothers underwent emergency and elective cesarean section at selected Addis Ababa governmental hospitals, Ethiopia from December 2018-May 2019.

In this study total magnitude of failed spinal anesthesia was 15.2% (121/794). From the total failed spinal anesthesia 19 (2.4%) was preoperative failure and 102(12.8%) was intraoperative failure.

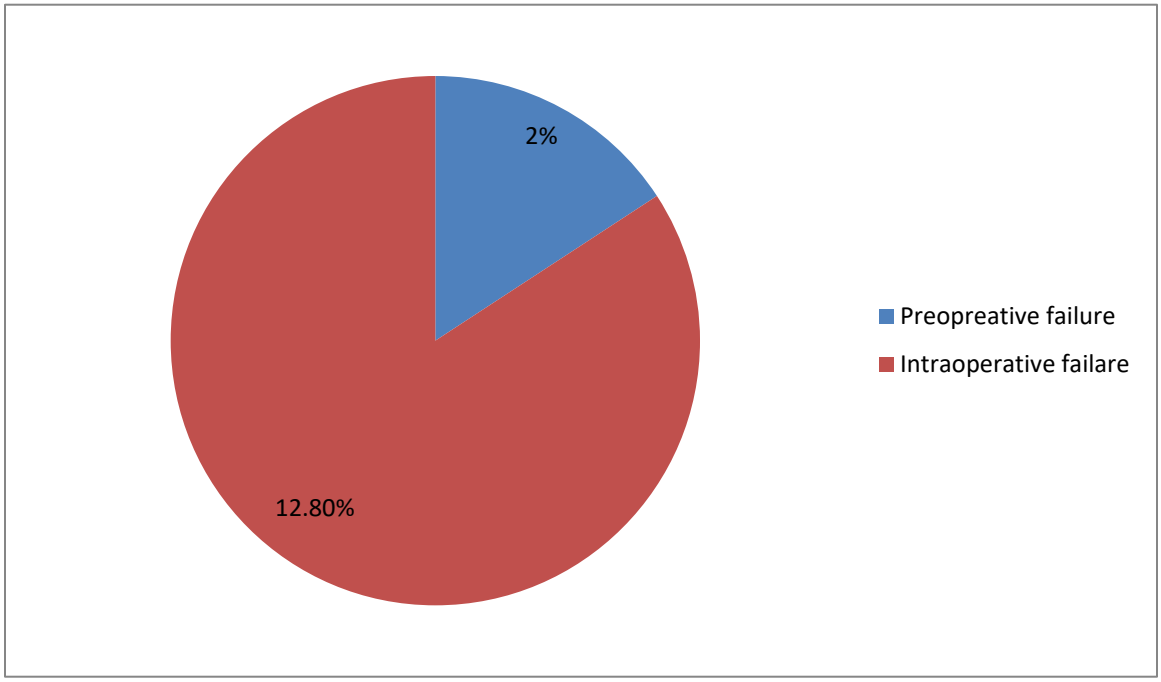

Figure 3: preoperative and intraoperative failed spinal anesthesia at Addis Ababa governmental hospital, Ethiopia from December 2018-May 2019

Regarding the type of failed spinal anesthesia 32(4%) was complete failed spinal anesthesia and 89(11.2%) was partial failed spinal anesthesia. With regard to failed spinal anesthesia management, these were rescued by conversion to general anesthesia (23%), repeating spinal anesthesia (3.3%) and IV analgesic supplementation (73.6%)

5.5 Factors associated with failed spinal anesthesia mothers underwent emergency and elective cesarean section at selected Addis Ababa governmental hospitals, Ethiopia from December 2018-May 2019.

.When adjusted to other variables, BMI ≥ 30kg/m^2, experience of anesthetist, patient position, number of attempt, appearance of CSF and dose of bupivacaine were associated with failed spinal anesthesia in cesarean section (Table IV).

In this study mothers whose BMI 30kg/m^2 and above were two times more likely to developed failed spinal anesthesia when compared with mothers whose BMI less than 30kg/m^2 (AOR=2.03,95%CI;1.12-3.68)).

Spinal anesthesia performed by anesthetist who had < 1 year experience was more than four times more likely to be failed compared with Spinal anesthesia performed by anesthetist who had experience > 1 year (AOR, 4.60, 95% CI; 2.80-7.56).

The study showed spinal anesthesia performed in lateral position was 14 times to be failed than spinal anesthesia performed in sitting position (AOR; 14.43, 95%CI;2.65-78.61).

Spinal anesthesia performed in bloody appeared CSF was six times more likely to be failed when compared with spinal anesthesia procedure with clear CSF (AOR=6.37, 95%CI,;2.90-13.96).

In this study spinal anesthesia procedures attempt > 1 were nine times to more likely be failed than procedures performed by 1 attempt (AOR; 9.26, 95% CI; 5.69-15.01).

Spinal anesthesia performed with < 10mg of bupivacaine was 2 times to be failed spinal anesthesia compared with those performed with ≥10mg of bupivacaine (AOR=2.37; 95%CI; 1.20-4.68).

Spinal anesthesia performed without the use of adjuvant was two times more likely to be failed than spinal anesthesia performed with adjuvant (AOR; 2.72, 95% CI;1.33-5.53).

Table 3: Factors associated with failed spinal anesthesia in cesarean section at Addis Ababa governmental hospital, Ethiopia from December –May 2018/2019.

Variables		Failed-spinal anesthesia		COR(95%CI)	AOR(95%CI)	P-value
		Yes n (%)	No n (%)			
BMI (Kg/m^2)	<30	92(11.6%)	579(73%)	1	1	0.02
	≥30	29(3.7%)	94(11.8%)	1.94 (1.21-3.11)	2.03(1.12-3.68)	
SA history	No	90(11.3%)	436(55%)	1	1	0.224
	Yes	31(3.9%)	237(29.8%)	0.65(0.41-0.98)	0.72(0.42-1.22)	
Experience of anesthetist	≥1 year	35(4.4%)	431(54.2%)	1	1	<0.0001
	< 1 year	86(10.8%)	242(30.5%)	4.38(2.87-6.68)	4.60(2.80-7.56)	
Patient position	Setting	115(14.5%)	670(84.4%)	1	1	0.002
	Lateral	6(0.76%)	3(0.38%)	11.65(2.87-47.25)	14.43(2.65-78.61)	
Appearance of CSF	Clear	99(12,5%)	652(82.1%)	1	1	0.001
	Bloody	22(2.8%)	21(2,6%)	6.90(3.69-13.00)	6.37(2.90-13.96)	
Numbers of attempt	1	50(6.3%)	583(73.4%)	1	1	<0.0001
	≥ 1	71(8.9%)	90(11.3%)	9.20(6.02-14.06)	9.26(5.69-15.06)	
Baricity of bupivacaine	Isobaric	110(13.9%)	638(80.4%)	1	1	0.66
	Hyperbaric	11(1.4%)	35(4.4%)	1.81(1.11-3.70)	0.967(0.40-2.32)	
Dose of bupivacaine in mg	≥ 10	102(12.8%)	608(76.6%)	1	1	0.013
	< 10	19 (2.4%)	65(8.2%)	1.74(1.00-3.03)	2.37(1.20-4.68)	
Adjuvant	Yes	17(2.14%)	160(20%)	1	1	0.006
	No	104(13%)	513(64.6%)	1,91(1.11-3.28)	2.72(1.33-5.53)	

Where: 1=reference group COR=crude odd ratio AOR= adjusted odd ratio CI= confidence interval n=number %= percent

Chapter six: discussion

Failed spinal anesthesia implies spinal anesthesia was attempted but unable to obtain correct intervertebral space or the block was not adequate to complete surgery (5). In this study magnitude of total failed spinal anesthesia was 15.2% which was in the range of 2.5%-17% failed spinal reported by different authors (32, 33, 34). Our finding was consistent from failed spinal rate 17% reported by Levy et al (32). But inconsistent to our study current literature reported 2%-4% incident rate in developed country (15). And also in this study magnitude of failed spinal anesthesia was slightly higher than the study done 2015 in Nigeria (9.1%) (13) and in 2017 south Africa (11.7%) (23). Possible justification could be due to Addis Ababa governmental hospitals are a trainee area also our data evidenced that spinal anesthesia performed by a trainee was more likely to be failed than spinal anesthesia performed by seniors. Which was supported by study done in 2011 by Pokharel, failed spinal anesthesia in the training area could be as high as 25% incidence rate (8).

Our study found 4.7% and 10.6% magnitude of failed spinal anesthesia for emergency and elective cesarean section, respectively which were not comparable from failure rates of less than 1% for electives and less than 3% for emergency Caesarean section suggested by the Royal College of Anesthetists (16). In contrast to other study classification of cesarean section was not a predictor for failed spinal anesthesia in this study.

These differences on the overall magnitude of failed spinal anesthesia could also be due to criterion of failed spinal anesthesia in this study, which included both preoperative and intraoperative failure. But in contrast to our study, study in done 1985 by Levy et al. spinal anesthesia is considered to have failed if anesthesia and analgesia have not taken effect within 10 minutes of successful intrathecal deposition of heavy bupivacaine and 25 minutes for plain bupivacaine (17). Another study 2018 by E. K. Aasvang et al. failed spinal anesthesia considered only if a patient required general anesthesia at any time during the surgical procedure (33).

From the variables considered in this study on multivariable logistic regression analysis Experience of anesthetist (<1 year), BMI $\geq 30 kgm^2$, patient position, bupivacaine dose <10mg, bloody appearance of CSF, number of attempt > 1 were associated factors for failed spinal anesthesia in cesarean section. In our study 11.2 % of failed spinal anesthesia requires intraoperative supplemental analgesia to complete surgery. But this was higher than 5,7%

reported in 2015 by Rukewe (5). Postgraduate year two (PGY-2) and some anesthetist practiced use of adjuvant in Addis Ababa governmental hospital during our study period 121(15.2%) mothers were taken adjuvant either intratheacal fentanyl or IV dexamethasone and those mothers who were not taken adjuvant were greater than 2 times more likely to require intraoperative analgesia. Possible justification could be since adjuvant potentiate local anesthetic and decrease intraoperative requirement of analgesia (7,10,25).

In our study duration of experience of anesthetists (<1year) was significant contributing factor for failed spinal anesthesia. Possible justification could be in Addis Ababa governmental hospital spinal anesthesia is performed by either student or senior anesthetists. And Student performs spinal anesthesia under supervision by seniors; so that when spinal anesthesia was challenged for student it could be performed by senior colleague if failure was happened preoperatively. But student might perform spinal anesthesia and failure could occur intraoperative this was explained as failed spinal anesthesia due to technical error like loss of injectate, misplace injection, solution selection error, in appropriate dose selection, incorrect positioning and in appropriate needle insertion due to those spinal anesthesia were became unilateral or inadequate sensory height of spinal anesthesia Our data suggested anesthetist experience (>1year) had lower failure as different authors have underscored the importance of clinical experience with neuraxial technique (7, 9).

In this study mothers whose BMI $\geq$ 30kem^2 were at higher odds of resulting in failed spinal anesthesia (FSA), this finding was consistent with study done 2017 by A.Alabi, et al. (23). But our finding was inconsistent with study done 2015 by Rekew (5). Possible reason could be due to anatomical challenges of accessing the intervertebral space and skills of anesthetist performing the spinal anesthesia(34). The obscured landmark in mothers whose BMI $\geq$ 30kem^2 makes the identification of the landmark for spinal anesthesia difficult to locate and it also affect distribution of local anesthetic(35).However, some studies did not report any difficulty in performing spinal anesthesia in obese pregnant women (5).

This study also showed as appearance of CSF (p= <0.0001) was contributing factors for failed spinal anesthesia. Our study was consistent with a study done 2017 by Alabi A et al. in which they found appearance of CSF was contributing factors for failed spinal anesthesia (P= <0.0001)

(23). This might be due to incorrect placement of spinal needle in the subarachnoid space, appearance of clear CSF in the needle hub is an essential pre-requisite for spinal anesthesia although it was not guarantee success (9).

In this study spinal anesthesia procedures taken greater than > 1 attempt was associated with failed spinal anesthesia which was consistent from the study done in 2007 by Rukewe, multiple punctures were associated with failed spinal anesthesia. But intervertebral space was not predictor for failed spinal anesthesia in our study as did by Rukewe where L4-L5 intervertebral space was associated with failed spinal anesthesia (5).

The speed of onset, quality, and duration of spinal anesthesia are determined by the dose of the local anesthetic(36). In this study the result demonstrated mothers who were taken (< 10mg of bupivacaine) was associated with failed spinal anesthesia compared with mothers who were taken (≥10mg of bupivacaine) which was inconsistent from the study done by Rukewe (5).

Longer duration of surgery increases intraoperative requirement of supplemental analgesia (anesthesia) to complete surgery like Postpartum sterilization, exteriorization uterus during surgery (7,10). But in our study duration of surgery was not associated with failed spinal anesthesia. Pregnant women at term require a smaller dose of intrathecal local anesthetic than non-pregnant women to produce the same level of spinal block due to physiological change. Gestational age was associated with failed spinal anesthesia in mothers who were preterm (<37weeks) resulted more failed spinal anesthesia than term(≥ 37weeks) in the study reported by Adesope et al. (18). In this study gestational age and failed spinal anesthesia were not associated.

6.1: Limitation study

- Limited availability of previous cross section study
- Sample size calculation relayed proportion of failed spinal anesthesia in Nigeria this was our challenge difference in the anesthesia practice of two countries.

6.2: Strength of the study

- We got adequate sample size within the planed period of time.
- Study participant were homogenous
- As far as my knowledge this is the first study in my study area so, it will be helpful as baseline information for other researchers.

Chapter seven: conclusion and recommendation

7.1 Conclusion

- Magnitude of failed spinal anesthesia in Addis Ababa governmental hospitals was high.
- Experience of anesthetist (<1 year), obesity, bupivacaine dose <10mg, bloody appearance of CSF, number of attempt > 1 were associated factors for failed spinal anesthesia in cesarean section. Therefore anesthetist should know all possible factors and develop strategy.

7.2 Recommendation

For anesthetist

- Anesthetist at Addis Ababa governmental hospital should know all possible factors associated with failed spinal anesthesia when we plan to perform spinal anesthesia.
- Use of adjuvant with local anesthetics should be a daily practice for Addis Ababa governmental hospitals

For stakeholders

- There should be a standard for spinal anesthesia in obstetric management and failed spinal management protocol.

For further researchers

- Further study with cohort study need to be conducted

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Annex

Annex 1: Conceptual frame work

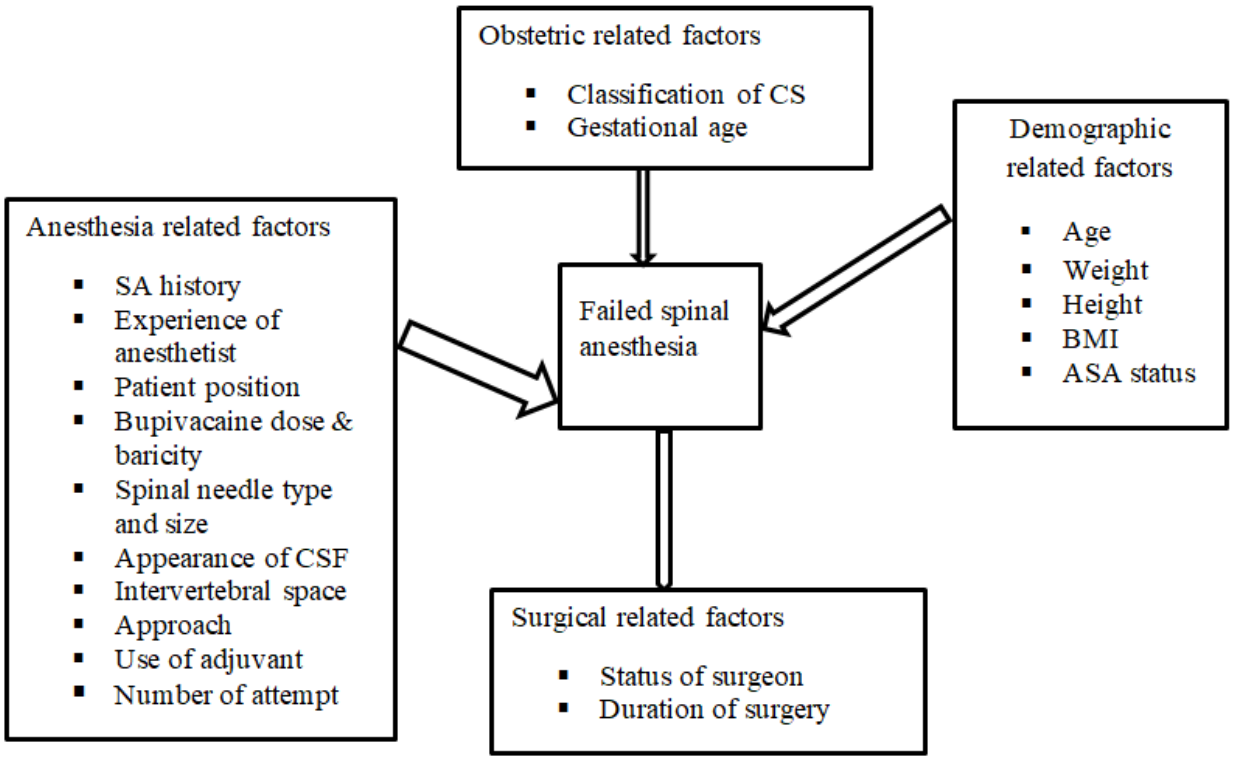

Figure 1: Conceptual framework on assessment and related risk factors of failed spinal anesthesia.

Annex II: Title: Magnitude and associated factors of failed spinal anesthesia in cesarean section at Addis Ababa governmental hospital. Ethiopia.

Thank you for agreeing to participate in this research project. This study is about magnitude and associated factors of failed spinal anesthesia Participation in this study will take approximately 5 minutes of your time. We do not anticipate you experiencing any discomfort or other negative feelings when responding to items in this study. Your participation in this study is completely voluntary. Should you decide to discontinue participation or decline to answer any specific part of the study, you may do so without penalty. Your participation in this study may help you understand the magnitude and associated factors of failed spinal anesthesia in cesarean section, as the procedures we are employing in this study are similar to the procedures that many other researchers employ. We are not asking you to place your name anywhere on the questionnaire, so your participation is anonymous. None of your answers can be directly traced back to you.

Should you have any further questions, please feel free to contact the study's principle investigator, Telephone 0933528263 and email abutbekele@gmail.com.

CONSENT STATEMENT: I, _____, hereby give my consent to participate in the research study entitled "magnitude and associated factors of failed spinal anesthesia in cesarean section." I have read the above information and am aware of the potential risks and complications. I fully understand that I may withdraw from this research project at any time without prejudice or effect on my standing with Addis Ababa governmental hospitals. I also understand that I am free to ask questions about techniques or procedures that will be undertaken. I will sign and return this consent form and receive a copy of the form in case I need to refer back to it.

Participant's signature Date

I hereby certify that I have given an explanation to the above individual of the contemplated study and its risks and potential complications.

Principal Investigator's signature Date

የ ማኪይቅ ፍቃድ

የ ተከበራችሁ የ ጥናቱ ተሳታፊዎች

አድስ አበባ ዩኒቨርሲቲ ጤፍ ሳይንስ ኮሌጅ፣ ህክምና ትምህርት ቤት፣ የ አንስቴዢያ ትምህርት ክፍል

የ ማኪይቅ ፈቃደኛነ ት ቅጽ

ስ ሜ_____ ይባላል፡ ፡

እኔ በአዲስ አበባ ዩኒቨርሲቲ በአንስቴዝያ ትምህርት ክፍል የ ምርምር ቡድን ዉስጥ አንድአባል ነኝ፡ ፡ .

በአጋጣሚ እርስዎም በዚህ ጥናት እንዲሳተፉ ተመርጠዋል፡፡ የዚህ ጥናት ጥቅም እርስዎ በሚሰጡት ምላሽ ማሳረት ሚጃዎችን በሞጁላት በማ ኘዉዉጩት ማሳረት ሚጃዎችን በማከናቀር ውጤቱን እየተሰራበት ካለውጋር ለ ማናዘብእንዲቻል ነዉ፡ በዚህምከዚህ ጥናት በኋላ ወደ ሆስፒታላችን ለሚሞኩህመማን የተሻለ ይረዳናል፡፡ ጥናቱ በትክክል አላማውን እንዲሞታ የእርሶዎን ድጋፉ እንጠይቃለን፡፡ የማንኛው ምላለሰብስም አይሜዝገብም እንዲሁም ሀሳቡብቻውን ይፉ እንዲዎጣ አይደረግም:: ማሉ በማሉ በሚስጥር የተጠበቀነዉ፡ በጥናቱ ማሳተፍ አለማሳተፍ የራስዎ ማብትብቻ ነዉ፡ ግልፅ የሆነ ምላሽን ና ከልብየማ ጨ ተሳትፎዎን እንዲሰጡን በአክብሮት እንጠይቃለን፡፡

ለማሳተፍ ፈቃደኛነዎት? ሀ/አዎፌርማ _____ ለ/ አይደለሁም

ለማሳተፍ ፈቃደኛ ስለሆኑ እናማሳ

Annex III

Questionnaire

Instruction: For each question, please circle the number of alternative (s) that fit the response. Fill the black space provided or choice from the given alternatives

Part I: Questionnaire on socio demographic characteristic of mothers

101	Age (years)	
102	Height (in meter)	
103	Weight (in Kg)	
104	BMI (kg/m^2)	
105	ASA physical status	A, ASA I B, ASA II

Part II: Questions on obstetric characteristics of mothers

106	Gestational age (in weeks)	
107	Classification of cesarean section	A, elective , B, emergency

108	Diagnosis	…….

Part III: Questions on anesthesia related characteristics

109	History of previous SA	A, yes B, no
110	Experience of anesthetist (in years)	A, < 1 B, ≥ 1
111	Position of mothers	A, sitting B,lateral
112	Approach	A, medial B, paramedial
113	Type of spinal needle	A, cutting B, pencile point
114	Needle size	…….
115	Number of attempt	1 2 3 >3
116	Flow of CSF	A, present B, absent
117	Appearance of CSF	A, clear B, bloody
118	Baricity of LA	A, isobaric B, hyperbaric
119	Dose of bupivacaine	…….
120	Height of sensory block	T8-T10 T6-T7 T4-T5
121	Intervertebral space	L2-L3 L3-L4 L4-L5
122	Motor grading (in bormatage score)	0 1 2 3
123	Adjuvant	A, yes B, no
124	Type of adjuvant	A, fentanyl B, dexamethasone

Part IV: Questions on surgical characteristics

125	Surgeon performing the procedure	R1 R2 R3 R4 consultant
126	Duration of surgery (in minutes)	A, < 45 B, 45-60 B, >45
127	Blood loss (in liters)	A, 0.5-1 B, >1

- ✓ Failed spinal anesthesia A, yes B, no

If your answer is yes continue to the next table

Part V: Questions if failed spinal anesthesia occur

128	when failure occur	A, Preoperative B, intraoperative
129	Type of failure	A, Complete B, partial
130	Supplemental drug used for partial	……..
131	Dose of supplemental drug	……..
132	If your answer is complete failure Type of anesthesia used after failure happened	A, general B, repeating spinal anesthesia
133	Time of conversion(in minutes)	0-30 30-60 >60
134	Complication of general anesthesia after conversion to GA	A, Aspiration B, difficult intubation

Appendex I: American Society of Anesthesiologists (ASA) physical status classification of patients.

Class	Definition
1	Normal healthy patient
2	Patient with mild systemic disease (no functional limitations)
3	Patient with severe systemic disease (some functional limitations)
4	Patient with severe systemic disease that is a constant threat to life (functionality incapacitated)
5	Moribund patient who is not expected to survive without the operation
6	Brain-dead patient whose organs are being removed for donor purposes
E	If the procedure is an emergency, the physical status is followed by "E" (for example, "2E")

Adopted from Morgan and Mikhail 5th edition

Annex IV: Classification of Obesity based on BMI.

BMI(kg/m2)	Description
<18.5	Underweight
18.5–24.9	Normal
25–29.9	Overweight
30–34.9	Obesity (class I)
35–39.9	Obesity (class II)
≥40	Morbid obesity (class III)
≥50	Super obesity

≥60 Super -super obesity

Adopted from Paul G. Barash clinical anesthesia 7th edition.