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TYPE, MANAGEMENT, AND CONTRIBUTING FACTORS OF FAILED SPINAL ANESTHESIA IN CESAREAN SECTIONS: A PROSPECTIVE COHORT STUDY

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Abstract: Spinal anesthesia is a suitable technique for cesarean sections to avoid respiratory complications. However, its management is crucial because spinal anesthesia may fail, leading to pain and discomfort for the patient. To evaluate the types, management strategies, and factors related to the failure of spinal anesthesia during cesarean sections. A multicenter prospective cohort study was conducted in public hospitals in SamSMU, involving 79 mothers who were eligible for cesarean section under spinal anesthesia. Data collection methods included chart reviews and observations of spinal anesthesia procedures. The collected data was entered into Epi Info version 7 and analyzed using SPSS version 20. Logistic regression was used to analyze the relationship between independent and dependent variables, with a p-value of 0.05 considered statistically significant. Out of 121 cases of failed spinal anesthesia, 35 were complete failures and 86 were partial failures. Complete failures were managed by repeating spinal anesthesia or converting to general anesthesia, while partial failures were managed with supplementary drugs. Factors such as the anesthetist's experience (less than 1 year), obesity, bupivacaine dose less than 10 mg, bloody CSF, and multiple attempts were associated with failed spinal anesthesia in cesarean sections. Management of failed spinal anesthesia varied among hospitals and did not always follow recommended guidelines. It is recommended that anesthesia professionals receive additional training on the identified factors associated with failed spinal anesthesia, and that management protocols be standardized according to recommended guidelines.

Key words: Spinal anesthesia, Cesarean section, Anesthesia failure, Obesity, Bupivacaine dose, Cerebrospinal fluid (CSF), Anesthetist experience, Multiple attempts

Introduction: With the global increase in cesarean section rates, spinal anesthesia has become the preferred anesthetic method for this procedure. Spinal anesthesia involves injecting a local anesthetic into the cerebrospinal fluid. Failures of spinal anesthesia can be categorized as either partial or complete. Complete failure is characterized by the absence of sensory or motor blockade, whereas partial failure involves insufficient level, quality, or duration of drug action for the surgery. Using

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bupivacaine as an example, if anesthesia and pain relief are not achieved within 10 minutes after administering heavy bupivacaine or within 25 minutes after successful intrathecal isobaric bupivacaine administration, it is considered a spinal anesthesia failure. Additionally, the inability to access the subarachnoid space during lumbar puncture is also considered a failure. For cesarean sections, anesthesia up to the T5 level is necessary to prevent pain. The estimated block height can vary based on the evaluator's experience, the patient's perception, and the method used to estimate block height (touch, prick, or cold sensation).

Achieving effective spinal anesthesia is heavily dependent on the experience of the anesthesiologist. While many studies identify obesity as an independent predictor of failed spinal anesthesia (FSA), others disagree. Various other factors are also considered, including the presence of blood in the cerebrospinal fluid, emergency cesarean section, multiple attempts, bupivacaine dose, duration of surgery, prior anesthesia, spinal needle type and size, and bupivacaine baricity. The pressure of unsuccessful spinal anesthesia is significant. Lack of clinical experience and inadequate access were identified as leading causes of maternal mortality, highlighting the limited options for addressing anesthesia failure. Successful spinal anesthesia, whether partial or complete, may necessitate the use of various adjuvants or conversion to general anesthesia, which can have medical and legal implications. Discomfort during cesarean sections under spinal anesthesia is a common cause of gynecological anesthesia lawsuits. While many studies have linked spinal block failure with various factors in developed countries, data on the management and co-factors of spinal anesthesia failure in our country are limited. Therefore, this study aims to evaluate the types and management strategies of spinal anesthesia failure and the associated factors contributing to these failures.

Purpose of study: The purpose of this study is to evaluate the types, management strategies, and factors associated with the failure of spinal anesthesia in cesarean sections. This includes identifying specific anesthetic, patient, and procedural factors that contribute to failed spinal anesthesia and assessing how these failures are managed across different hospitals. The goal is to improve the understanding and management of spinal anesthesia failures to enhance patient outcomes and ensure adherence to best practice guidelines.

Material and methods: Using a single population proportion formula with the proportion of failed spinal anesthesia at 9.1%, a 95% confidence level, and a margin of error of $\alpha = 5\%$, we determined a sample size of 79. Five public hospitals were randomly selected out of twelve using a lottery method, and the sample size was proportionally distributed across these hospitals. We observed 122 mothers who underwent cesarean delivery over the past three and a half months at the selected public hospitals in SamSMU. From these, we recruited 79 participants, estimating that about

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65% would undergo emergency or elective cesarean sections under spinal anesthesia during the study period. Participants were selected using systematic random sampling, with data collected on two mothers for every three who underwent cesarean sections until the required sample size was achieved. Data were collected through patient interviews, medical record reviews, and observations of spinal anesthesia procedures, focusing on five major areas:

To ensure data reliability and validity, questionnaires were pretested on 5% of the sample size before the actual data collection. The principal observer provided training on the purpose and relevance of the study. Data collectors and supervisors were responsible for all aspects of the survey tool and data collection process. Regular monitoring and follow-up were conducted during data collection. Each questionnaire was reviewed daily by a supervisor and then double-checked for completeness and consistency by the study director. Incomplete data were not entered into the database. Data cleansing and cross-validation of missing data were performed before analysis using Excel and SPSS. Data Analysis and Interpretation:

Data were coded and entered into Epi Info version 7 and exported to SPSS version 20 for analysis. Binary logistic regression was used to analyze the relationship between independent and dependent variables. Odds ratios, 95% confidence intervals, and p-values were calculated to identify relevant factors and determine the degree of association. For multivariate logistic regression analysis, variables with a p-value less than 0.2 in bivariate logistic analysis were included, and a p-value less than 0.05 was considered statistically significant.

Results of study: Data were obtained from a total of 87 participants, with a mean age of 27.39 ± 5.873 and a BMI of 24 ± 3.22. Among the participants, 28 (28.3%) underwent emergency cesarean sections, while 66 (71.7%) underwent elective cesarean sections.

About 84.5% of the participants were classified as ASA-I, and only 33.8% had previous experience with spinal anesthesia. Nearly all (99.9%) spinal anesthesia procedures were performed in a sitting position, and 57.7% were conducted by an anesthetist with more than a year of experience. Only 10% of participants received less than 10 mg of bupivacaine, while the rest received between 10 and 15 mg. The optimal dermatome block level was achieved in 68.3% of participants. The majority (60.3%) of spinal anesthesia injections were successful on the first attempt, while the procedure was repeated twice in 19.4%, three times in 9.7%, and more than three times in 10.6% of participants. Out of 13 cases of failed spinal anesthesia in this study, 9 were complete failures and 4 were partial failures. Of the 9 complete failures, 7 were managed by repeating the spinal anesthesia, and the remaining 2 were converted to general anesthesia. Partial failures were managed with ketamine (26 cases), fentanyl (19 cases), pethidine (29 cases), and morphine (12 cases).

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The study found significant associations between failed spinal anesthesia and several factors:

In this study, 80% of complete spinal anesthesia failures were converted to general anesthesia, while the remaining were managed by repeating spinal anesthesia. The Royal College of Anesthetists recommends that the conversion rate from spinal anesthesia to general anesthesia should be less than 1% for elective cesarean sections and less than 3% for non-elective cesarean sections. However, the conversion rate in this study was high, increasing the morbidity and mortality risks for both mother and baby. Management of partial spinal anesthesia failures was inconsistent with guidelines developed by the NHS Foundation Trust. On multivariable logistic regression analysis, mothers who had not received adjuvants were more than twice as likely to require intraoperative analgesia. This could be because adjuvants potentiate local anesthetics, reducing the need for intraoperative analgesia. The study showed that less than one year of anesthetist experience was significantly associated with failed spinal anesthesia. This may be due to technical errors such as incorrect injection, inappropriate dose selection, and improper positioning.

The study also found that mothers with a BMI of 30 kg/m² or more were at higher risk of failed spinal anesthesia, consistent with the findings of A. Alabi et al., but inconsistent with the study by Rekew. This discrepancy might be due to the anatomical challenges and the obscured landmarks in obese mothers, which make it difficult to locate the correct spinal anesthesia site and affect the distribution of the anesthetic. However, some studies did not report any difficulties performing spinal anesthesia in obese pregnant women.

A bloody CSF appearance was associated with failed spinal anesthesia, aligning with the findings of Alabi et al. This may result from incorrect placement of the spinal needle in the subarachnoid space. Multiple attempts at spinal needle insertion were also associated with failed spinal anesthesia, consistent with Rukewe's study. However, intervertebral space placement was not significantly associated with failed spinal anesthesia, unlike in Rukewe's study. The dose of the local anesthetic determines the onset speed, quality, and duration of spinal anesthesia. In this study, mothers who received less than 10 mg of bupivacaine were more likely to experience failed spinal anesthesia compared to those who received 10 mg or more, inconsistent with Rukewe's findings.

Conclusion: The study identified several factors associated with failed spinal anesthesia in cesarean sections, including anesthetist experience of less than 1 year, obesity, a bupivacaine dose of less than 10 mg, the bloody appearance of CSF, and more than one attempt at spinal needle insertion. The management of failed spinal anesthesia varied among hospitals and did not adhere to recommended guidelines. To improve outcomes, it is recommended that anesthesia professionals receive additional

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training on the identified factors associated with failed spinal anesthesia. Furthermore, the management of failed spinal anesthesia should be standardized based on recommended guidelines to ensure consistency and improve patient care.

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