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# Frequency of Failed Spinal Anesthesia and Associated Factors in Cesarean Section at Mardan Medical Complex, Mardan, KP, Pakistan

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***Abstract***

***Objective:*** *Spinal anesthesia is the preferred choice of anesthesia for parturients having cesarean sections. Despite the high percentage of success in providing acceptable surgical anesthesia, failure of spinal anesthesia has been reported. This study aims to determine the frequency and associated factors related to failed spinal anesthesia during cesarean sections in pregnant women.* ***Methodology****: This descriptive cross-sectional study included 149 pregnant women and was conducted at Mardan Medical Complex (MMC) between April and September 2023. Pregnant women having cesarean sections elective or emergency were administered 10–15 mg of 0.75% hyperbaric bupivacaine using a 23–25G Quincke spinal needle. A pre-designed questionnaire was used to document patient demographics, clinical details, as well as spinal anesthesia details of each patient. All the variables were analyzed with the help of SPSS version 22.* ***Results:*** *Among the 149 pregnant women who received spinal anesthesia, 17 (11.4%) experienced "failed" outcomes, where the spinal anesthesia did not work as intended. Conversely, 132 (88.6%) had "successful" outcomes, indicating effective administration of spinal anesthesia. A portion of 11 (8.7%), represented "partial failure," where the anesthesia had some success but did not achieve adequate anesthesia. While complete failure accounted for 4 (2.7%) of cases, signifying instances where spinal anesthesia did not work completely.* ***Conclusion and Recommendations:*** *The frequency of failed spinal anesthesia in pregnant women undergoing cesarean section at MMC was high at 11.40%.*

**Keywords:** Cesarean section, spinal anesthesia, failed spinal anesthesia, associated factors

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## INTRODUCTION

Spinal anesthesia is the preferred choice for parturients undergoing cesarean section [1]. Recently, there has been a growing trend towards the utilization of regional anesthesia in obstetrics. This shift can be attributed to the well-documented advantages it offers in terms of superior maternal and fetal outcomes compared with general anesthesia [2].

Spinal anesthesia is used over other techniques for several reasons, including its ease of introduction, quick initiation of sensory blockade, reliability, ease of learning, and ability to produce optimal surgical conditions. Additionally, neuraxial anesthesia results in less acute neonatal depression

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than general anesthesia [3]. In previous studies, this method has been proven to be safer than general anesthesia [4, 5]. Over the past two decades, increased rates of cesarean sections have been reported in both developed and developing countries. Spinal anesthesia is the most commonly used anesthetic procedure [6].

Despite the high success rate of providing acceptable surgical anesthesia, failure of spinal anesthesia has been reported following the injection of a local anesthetic (LA) into the cerebrospinal fluid (CSF) [7]. The term “failed spinal anesthesia” has many definitions, but most publications classify it into two categories. In the first phase, partial failure occurs when pain or discomfort occurs during surgery and requires additional intravenous analgesics or inhalation. While complete failure occurs when adequate sensory blockade cannot be achieved, general anesthesia or repeated spinal anesthesia is required[1, 5, 6]. Spinal anesthesia failure was also considered if anesthesia and pain relief could not be achieved within 10 min. following hyperbaric bupivacaine administration or within 25 min following successful intrathecal isobaric bupivacaine administration. Anesthesia up to T5 is required to prevent pain during cesarean section [8].

There have been a wide range of published statistics on failed spinal anesthesia, ranging from 0.5% to 6.4%. However, an American teaching hospital has reported a rate as high as 17% [1, 2, 7]. Recent studies have reported varying incidences ranging from 2.7% to 11.7% [5]. The lowest incidence rates were observed in developed countries, which could be attributed to advancements in modern anesthesia practices and the presence of highly skilled anesthesia providers [3]. The incidence of spinal anesthesia failure is extremely low (less than 1 percent) for most experienced practitioners [9]. An acceptable success rate for spinal anesthesia can be ensured if the anesthesia provider performing the procedure is well-informed about all possible technical mistakes that might cause the spinal block to fail [10].

Successful spinal anesthesia depends on the anesthesiologist’s experience. Many studies have considered obesity to be an independent predictor of failed spinal anesthesia, but others disagree. Several other factors were also considered, including blood in the CSF, emergency cesarean section, multiple attempts, bupivacaine dose, duration of surgery, previous anesthesia, spinal needle size, and bupivacaine baricity. This is due to the heavy pressure caused by unsuccessful spinal anesthesia [11]. Failure must be minimized to maximize the benefits of spinal anesthesia; failure must be minimized. The key to prevention lies in understanding potential challenges and tailoring clinical practices accordingly [12]. Many studies have noted the following problems associated with spinal anesthesia, even though it is a generally safe procedure: hypotension, vomiting, hematoma, cardiac arrest, shivering, and headache [13]. Many studies have noted the following problems associated with spinal anesthesia, even though it is a generally safe procedure: hypotension, vomiting, hematoma, cardiac arrest, shivering, and headache [13]. Hypotension is the most common complication of spinal anesthesia [3, 14].

Data on the frequency of failed spinal anesthesia have been previously published in Pakistan; however, data on the associated co-factors of spinal anesthesia failure are limited in Pakistan. To address this knowledge gap, we conducted a cross-sectional study of pregnant women undergoing cesarean sections. Therefore, understanding the frequency and associated co-factors of spinal anesthesia failure is crucial for improving patient safety and optimizing anesthesia management during cesarean sections.

## MATERIALS AND METHODS

This cross-sectional study was conducted in Mardan Medical Complex, Mardan, KP, Pakistan, from April 2023 to September 2023. A non-probability, simple, and convenient method was used. A total of 150 samples were calculated using OpenEpi. Com Sample Size Calculator. We excluded one case from the sample size because spinal anesthesia was planned, but unexpectedly, cesarean section was performed using general anesthesia instead. The sample size for this study was determined by considering the anticipated incidence of failed spinal anesthesia among pregnant women undergoing cesarean section, which was estimated to be 6% [15]. The margin of error was 1% and the confidence

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interval was 99%. Based on the standard normal distribution table, the corresponding Z-value was 2.576 for a 99% confidence interval.

A pre-designed questionnaire was used to collect data from all parturients who met our inclusion criteria for cesarean section under spinal anesthesia. For each eligible pregnant woman who consented to participate, a research questionnaire was completed that recorded demographic information, clinical information, and details about spinal anesthesia.

Patients were prepared by inserting an 18 or 20 G I.V. cannula and administering 1000–2000 ml of crystalloid fluid (lactated Ringer's or 0.9% Normal saline). Vital signs were monitored using noninvasive blood pressure, pulse oximetry, and electrocardiography. The patient was placed in a seated, and strict aseptic measures were taken, followed by povidone-iodine solution. To initiate spinal anesthesia, after identifying the L3–4 intervertebral space, the anesthesia provider locally applied a numbing agent, specifically 2% plain lignocaine (3–5 ml), and performed a lumbar puncture with a midline approach using a 25–23-gauge Quincke-Babcock spinal needle. Once the free-flow of CSF was confirmed, 10–15 mg of 0.75% hyperbaric bupivacaine was injected into the intrathecal space. Subsequently, the patient was positioned supine with a 20-degree left tilt.

The spinal level of anesthesia was checked by a surgeon using non-toothed forceps. Surgical intervention was initiated upon achieving an effective block. In cases of partial spinal anesthesia failure, sedation and analgesia were administered using intravenous injections of ketamine, propofol, and midazolam (2 mg). Complete spinal anesthesia failure led to either repeated spinal anesthesia or conversion to general anesthesia. In cases of hypotension during surgery, the anesthesia provider treated the patient with intravenous fluid infusions or phenylephrine.

All variables were analyzed using SPSS version 22. Student's t-test and the chi-square test were used to analyze the contributing factors related to block failure. Statistical significance was set at $P < 0.05$.

## RESULTS

In total, 149 analyses were performed. The average age of these women was 26.91 (26.91±5.35) with a minimum age of 18 years and a maximum age of 40 years, as shown in Table 1 and Figure 1. The average body mass index (BMI) was 27.29 (27.29±3.38); 35 (23.5%) of the participants were of normal weight, 85 (57%) were classified as overweight, and 29 (19.5%) were obese. These subjects were further classified based on obesity, which demonstrated that 25 (16.8%) fell into obesity class I and four (2.7%) were obese class II. The average weight of these participants was 72.76 (72.76±7.738) kg, and their average height was 163.72 (163.72±8.262) cm.

**Table 1.** Demographic characteristics of pregnant women.

| Variables | Frequency, n (%) | Mean |
|---|---|---|
| Age (years) | | 26.91 (26.91±5.35) |
| 18–22 | 37 (24.8%) | |
| 23–26 | 36 (24.2%) | |
| 27–29 | 23 (15.4%) | |
| 30+ | 53 (35.6%) | |
| Mean height (cm) | | 163.72 (163.72±8.262) |
| Mean weight | | 72.76 (72.76±7.738) |
| Mean BMI (kg/cm$^2$) | | 27.29 (27.29±3.38) |
| Normal weight | 35 (23.5%) | |
| Overweight | 85 (57.0%) | |
| Obese | 29 (19.5%) | |
| Obesity Class I | 25 (16.8%) | |
| Obesity Class II | 4 (2.7%) | |

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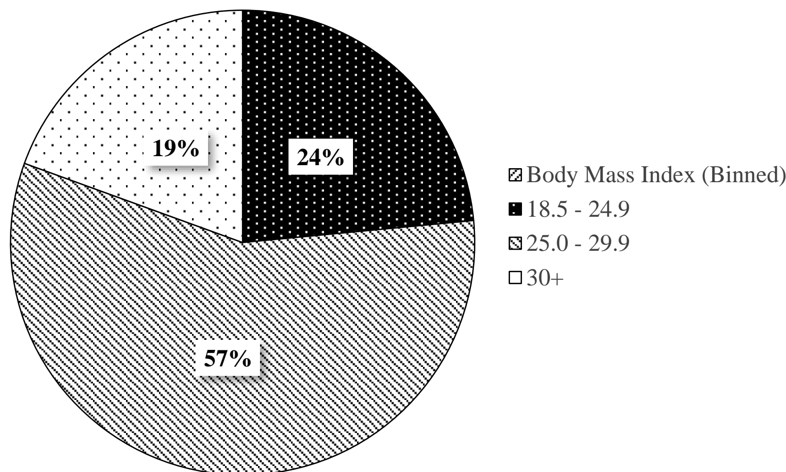


**Figure 1.** Body mass index distribution of pregnant women.

**Table 2.** Frequency of spinal anesthesia outcomes.

| | Frequency | Percent |
|---|---|---|
| Failed | 17 | 11.4 |
| Successful | 132 | 88.6 |
| Total | 149 | 100.0 |

Among the 149 pregnant women who received spinal anesthesia, 17 (11.4%) experienced "failed" outcomes, where the anesthesia did not work as intended (Table 2). Conversely, 132 (88.6%) patients had "successful" outcomes, indicating effective administration of spinal anesthesia. A portion of, 11 (8.7%), represented "partial failure," where the anesthesia had some success but did not achieve adequate anesthesia for a cesarean section the management approach was the administration of low-dose midazolam and ketamine or a combination of ketamine and propofol. "Complete failure" accounted for four (2.7%) cases, signifying instances where spinal anesthesia did not work completely, which was successfully managed by repeating the spinal anesthesia procedure in one, while the remaining three were converted into general anesthesia.

**Table 3.** Mean comparison of the demographic characteristics of failure and successful groups.

| | Spinal anesthesia | Mean | Std. deviation |
|---|---|---|---|
| Age | Failed | 28.06 | 5.942 |
| | Successful | 26.76 | 5.282 |
| Weight in kg | Failed | 75.35 | 10.571 |
| | Successful | 72.42 | 7.281 |
| Height in cm | Failed | 163.53 | 8.255 |
| | Successful | 163.75 | 8.295 |
| Body Mass Index | Failed | 28.5000 | 2.87228 |
| | Successful | 27.1392 | 3.42557 |
| Duration of Surgery | Failed | 52.41 | 6.345 |
| | Successful | 43.58 | 6.937 |

The average weight of the failed spinal cord group was higher (75.3 kg) than that of the successful spinal cord group (72.42 kg) (Table 3). The mean BMI for failed spinal cases was 28.5, with a standard deviation of 2.87, whereas the mean BMI for successful spinal cases was 27.1, with a standard deviation of 3.42. Surgery took longer (5.41 min) in the spinal anesthesia failure group than in the successful spinal anesthesia group (43.58 min).

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**Table 4.** Association of clinical determinants with spinal anesthesia failure and its risk analysis.

| Variables | | Failed n=17 (%) | Successful n=132 (%) | RR (95%CI) | Chi-Square test | P-value |
|---|---|---|---|---|---|---|
| ***1. Pregnancy status*** | | | | | | |
| | Primigravida | 6 (11.1) | 48 (88.9) | .960 (376–2.4494) | .007 | .931 |
| | Multigravida | 11 (11.6) | 84 (88.4) | | | |
| ***2. Indication of C-section*** | | | | | | |
| | Elective SC | 5 (8.6) | 53 (91.4) | .654 (.243–1.759) | .731 | .393 |
| | Emergency SC | 12 (13.2) | 79 (86.8) | | | |
| ***3. Number of previous C-sections*** | | | | | | |
| | 0 | 0 (0) | 1 (100) | | 1.344 | .719 |
| | 1 | 7 (9.7) | 65 (90.3) | | | |
| | 2 | 7 (15.9) | 37 (84.1) | | | |
| | 3 | 3 (9.4) | 29 (90.6) | | | |
| ***4. Type of cesarean*** | | | | | | |
| | Low transverse | 16 (10.8) | 132 (89.2) | .108 (.068–.172) | | .114* |
| | vertical | 1 (100) | 0 (0) | | | |
| ***5. Gestational age*** | | | | | | |
| | <37 weeks | 0 (0) | 9 (100) | | 2.692 | .611 |
| | 37 weeks | 3 (8.8) | 31 (91.2) | | | |
| | 38 weeks | 10 (15.6) | 54 (84.4) | | | |
| | 39 weeks | 2 (10.5) | 17 (89.5) | | | |
| | 40 weeks | 2 (8.7) | 21 (91.3) | | | |
| ***6. Loss of sensation to pinprick test*** | | | | | | |
| | Yes | 13 (9.3) | 127 (90.1) | .209 (.085–.511) | | .010* |
| | No | 4 (44.4) | 5 (55.6) | | | |
| ***7. Local anesthetic used*** | | | | | | |
| | Bupivacaine | 17 (12.5) | 119 (87.5) | | | 0.364* |
| | Bupivacaine+Lidocaine | 0 (0) | 13 (100) | | | |

The chi-square test for the association between risk factors and spinal block showed no evidence of statistical significance (p>0,05). For the risk factor pregnancy status, it was observed that the percentage of failure in multigravidas was higher in 11 (11.6%) than in prime gravidas. The emergency C-section depicted a high percentage of 12 (13.2%) compared to elective C-section 5 (8.6%). We identified a significant association between the risk factors for loss of sensation in the pinprick test and spinal block (Fisher's exact test, p=.010). As one of the cell counts was less than 5, as shown in Table 4, Fisher's exact test was used instead of the chi-squared test. However, a risk ratio of.209 (.085–.511), which is less than 1, revealed a decreased risk in the exposed group compared to the non-exposed group. Bupivacaine, a local anesthetic, showed a 12.5% failure rate, whereas the combination of Bupivacaine and Lidocaine had a 0% failure rate.

The failure rates of resident anesthetists, anesthesiologists, and nurse anesthetists were 12.5%, 10.7%, and 20%, respectively. No statistically significant variation was observed in the failure rates for different levels of experience (1–2 years, 3–4 years, and >4 years). Procedural factors, such as the choice of spinal needle type and gauge, did not significantly affect outcomes. Most risk factors in the provider-related list were statistically significant. Based on Fisher's exact test, the number of skin punctures was significant (p<.001). The risk ratio of.164 (.061–.436) indicates that the risk of anesthesia failure decreased with a smaller number of skin punctures. Confirmation of arachnoid puncture in the presence of free-flow CSF resulted in a lower failure rate (10.2%) than the absence of free-flow CSF (100%

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failure). CSF characteristics, particularly bloody CSF, demonstrated a higher failure rate (37.5%) than non-bloody CSF characteristics (9.9%). The block levels significantly influenced the outcomes, with T8–T10 resulting in a 100% failure rate. Adjuvants were used in only 17 cases, and only four cases showed partial failure. These findings offer valuable insights into the factors influencing success rates in the context of the procedures studied and contribute to the understanding of relevant clinical considerations (Table 5).

**Table 5.** Provider-related risk factors associated with spinal anesthesia failure and risk analysis.

| Variables | | Failed n=17 (%) | Successful n=132 (%) | RR (95%CI) | *Chi-square test* | *P-value* |
|---|---|---|---|---|---|---|
| ***1. Provider rank*** | | | | | | |
| | Resident Anesthetics | 4 (12.5) | 28 (87.5) | | .456 | .796 |
| | Anesthesiologist | 12 (10.7) | 99 (89.3) | | | |
| | Nurse Anesthetist | 1 (20) | 4 (80) | | | |
| ***2. Work experience*** | | | | | | |
| | 1–2years | 7 (17.1) | 34 (82.9) | | 1.796 | .407 |
| | 3–4years | 8 (9.3) | 77 (90.7) | | | |
| | >4years | 2 (9.1) | 20 (90.9) | | | |
| ***3. Spinal needle type and gauge*** | | | | | | |
| | 23G | 0 (0) | 16 (100) | | 2.471 | .291 |
| | 25G | 17 (12.9) | 115 (87.1) | | | |
| | 27G | 0 (0) | 1 (100) | | | |
| ***4. Number of skin punctures*** | | | | | | |
| | Once | 5 (4.7) | 102 (95.3) | .164 (.061–.436) | | <.001* |
| | Multiple | 12 (28.6) | 30 (71.4) | | | |
| ***5. Confirmation of arachnoid puncture*** | | | | | | |
| | Presence of free-flow CSF | 15 (10.2) | 132 (89.8) | .102 (.063–.165) | | .012* |
| | Absence of free-flow CSF | 2 (100) | 0 (0) | | | |
| ***6. Characteristics of CSF*** | | | | | | |
| | Bloody | 3 (37.5) | 5 (62.5) | 3.77 (1.35–10.51) | | .049* |
| | Non-Bloody | 14 (9.9) | 127 (90.1) | | | |
| ***7. Block level*** | | | | | | |
| | T8–T10 | 5 (100) | 0 (0) | | 43.708 | <.001 |
| | T6–T7 | 5 (8.5) | 54 (91.5) | | | |
| | T4–T5 | 6 (7.2) | 77 (92.8) | | | |
| | None | 1 (50) | 1 (50) | | | |
| ***8. Adjuvant use*** | | | | | | |
| | yes | 4 (23.5) | 13 (76.5) | 2.39 (.88–6.49) | | .108* |
| | No | 13 (9.8) | 119 (90.2) | | | |

Table 6 presents the incidence of intraoperative complications during spinal anesthesia in pregnant women, both in cases where anesthesia was successful and in cases where it failed. Hypotension was observed in six cases (4%) among those with failed anesthesia and in 19 cases (12.75%) among those with successful anesthesia. Headaches occurred in 2 cases (1.34%) in the failed group and 6 cases (6.04%) in the successful group. Shivering was reported in three cases (2%) with failed anesthesia and in 11 cases (7.38%) with successful anesthesia. Nausea was experienced in six cases (4.2%) in the failed group and 15 cases (10.6%) in the successful group. Vomiting was relatively rare, with one case (0.6%) in the failed group and two cases (1.34%) in the successful group.

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**Table 6.** Intraoperative complications in spinal anesthesia.

| | | | Spinal anesthesia | | Total |
|---|---|---|---|---|---|
| | | | *Failed* | *Successful* | |
| Intraoperative complications | Hypotension | Count | 6 | 19 | 25 |
| | | % within | 4% | 12.75% | |
| | Headache | Count | 2 | 6 | 8 |
| | | % within | 1.34% | 6.04% | |
| | Shivering | Count | 3 | 11 | 14 |
| | | % within | 2% | 7.38% | |
| | Nausea | Count | 6 | 15 | 21 |
| | | % within | 4.2% | 10.6% | |
| | Vomiting | Count | 1 | 2 | 3 |
| | | | 0.6% | 1.34% | |

## DISCUSSION

Regional anesthesia has greatly benefited obstetric surgeries by substantially reducing maternal mortality rates as the utilization of neuraxial anesthesia increases. Despite the numerous advantages associated with spinal anesthesia, its failure can be a distressing situation for both the patient and the anesthesiologist. Several reports of unsuccessful spinal anesthesia have been documented in the existing literature [12, 16].

The primary outcome of this study was the success or failure of spinal anesthesia. Among the 149 pregnant women who received spinal anesthesia, 17 (11.4%) experienced "failed" outcomes, where the anesthesia did not achieve the desired effect. Partial failure occurred more frequently than complete failure. The frequency of failed spinal anesthesia at the MMC was high, as found in other studies [7, 14, 17, 18]. This frequency of failed spinal anesthesia was greater than that reported in other studies [5, 18]. The results of this study exceeded the standard established by the Royal College of Anesthetists. The College suggests a failure rate of less than 1% for elective procedures and less than 3% for emergency cesarean sections [9].

Most cases of unsuccessful spinal anesthesia occur intraoperatively. In this study, we only used hyperbaric bupivacaine 0.5% as the local anesthetic agent, unlike other studies where they also used additional drugs such as opioids and bupivacaine, which tended to result in fewer cases of failed spinal anesthesia [3, 7]. Hyperbaric bupivacaine was the only local anesthetic used during our study period, in contrast to other studies that indicated that the use of opioids along with bupivacaine was associated with a lower rate of spinal anesthesia failure [5, 17].

We conducted a comparative analysis between the failed and successful groups to explore the risk factors associated with spinal anesthesia failure. Several key factors have emerged as potential contributors to spinal anesthesia failure. Notably, the average BMI was higher in the failed group (28.50) compared to the successful group (27.14). However, the frequency of failed spinal anesthesia in this study did not seem to be associated with BMI, as shown in other studies [11, 14]. According to Bamobade et al., determining the landmark for spinal anesthesia is more challenging in obese parturients because the landmark is often obscured [19]. Another factor was the duration of surgery, which was significantly longer in the failed spinal anesthesia group (52.41 minutes) than in the successful group (43.58 min). This difference was statistically significant, indicating that prolonged surgical procedures may pose a higher risk of spinal anesthesia failure.

We also observed that spinal anesthesia failure increases when dealing with patients who are not cooperating with the anesthesia provider and when the local anesthetic, such as bupivacaine, is not within its coolness chain of 4–8°C also shown in a study conducted by CK Shrestha [13]. We found that these factors play a significant role in causing spinal anesthesia failure during cesarean sections.

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Provider-related risk factors were also examined, including provider rank, work experience, spinal needle type, gauge, number of skin punctures, confirmation of arachnoid puncture, CSF characteristics, block level, and adjuvant use. Several of these factors are significantly associated with spinal anesthesia failure. The appearance of bloody CSF aligns with the findings reported by Alabi et al. [17]. This may be caused by incorrect placement of the spinal needle in the subarachnoid space, although clear CSF in the needle hub is an essential prerequisite for spinal anesthesia [11]. Multiple skin punctures were also strongly associated with failure, with a smaller number of punctures being associated with a reduced risk of failure, which is consistent with the outcomes reported in Rukewe's study [7]. Multiple skin punctures are usually caused by difficulty in locating landmarks, resulting in complications. Low BMI, low weight, and young age were predictors of a successful first puncture [21]. Confirmation of arachnoid puncture was also significantly related to failure, with the presence of free-flowing CSF indicating a decreased risk of failure. Block levels are also associated with failure of spinal anesthesia. This factor has the highest percentage at the T8–T10 block level. In previous studies, a block height of T5 was found to be adequate for cesarean sections [22].

In this study, we observed intraoperative complications, with hypotension, nausea, and shivering being the most common. Other studies have reported hypotension as the most common complication [3, 14].

**Study Limitations**

1. This study was conducted at a single hospital, the Mardan Medical Complex, which may limit the generalizability of the findings to other healthcare settings.
2. Although calculated with precision, the sample size of 150 participants was relatively small.
3. The study was conducted for a relatively short period.

## CONCLUSION

The frequency of unsuccessful spinal anesthesia in pregnant women undergoing cesarean section at the MMC was high (11.40%). Most cases of failed spinal anesthesia are characterized by partial failure. Several factors have been identified as potential contributors to failed spinal anesthesia. Emergency cesarean section, multiple pricks, bloody CSF, uncooperative behavior of the patient in position making, bupivacaine when kept at high temperature, absence of pinprick sensation, and block level. Understanding and mitigating the risk factors associated with failed spinal anesthesia are crucial for enhancing the overall quality of obstetric care.

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