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FACTORS OF FAILED SPINAL ANESTHESIA IN DIFFERENT SURGICAL PROCEDURES AT TERTIARY CARE HOSPITALS DISTRICT PESHAWAR, PAKISTAN

Original Research

Hazrat Ali[1], Asad Ullah[1], Khush Noor[1], Nadeem Ullah Khan[1], Shahzaib[1], Maheen Najeeb[2]*, Alam Zeb[3]
[1]Sarhad University of Information Technology SUIT, Peshawar, Pakistan.
[2]Lecturer, Sarhad University of Information Technology SUIT, Peshawar, Pakistan.
[3]Kaul Associate, National Hospital Lahore, Pakistan.
Corresponding Author: Maheen Najeeb, Lecturer, Sarhad University of Information Technology SUIT, Peshawar, Pakistan, maheennajeeb27@gmail.com
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ABSTRACT

Background: Spinal anesthesia is a widely preferred technique for surgeries involving the lower extremities and abdomen due to its rapid onset, predictable blockade, and reduced systemic complications. Despite its efficacy, failures still occur, leading to intraoperative discomfort, delayed procedures, or conversion to general anesthesia. Understanding the underlying demographic and procedural factors influencing spinal anesthesia outcomes is essential to enhance safety and effectiveness in clinical practice.

Objective: To identify patient-specific and procedural factors associated with the success and failure of spinal anesthesia in surgical patients.

Methods: A cross-sectional analytical study was conducted on 175 patients undergoing various elective and emergency surgeries under spinal anesthesia. Data on patient demographics, BMI, clinical history, surgery type and urgency, needle type, number of puncture attempts, local anesthetic type and dose, and intraoperative pain were collected. Logistic regression was used to identify significant predictors of spinal anesthesia failure, with statistical significance set at $p<0.05$.

Results: Spinal anesthesia failed in 15 out of 175 patients (8.57%). Significant predictors included underweight status (OR 4.76, p=0.049), obesity (OR 3.21, p=0.074), back pain history (OR 6.31, p=0.003), and previous spine surgery (OR 9.14, p=0.001). Procedural risk factors were Quincke needle use (OR 3.82, p=0.027), multiple puncture attempts—especially more than three (OR 10.53, p=0.002), use of Lidocaine (OR 10.5, p=0.001) or Ropivacaine (OR 8.4, p=0.018) instead of Bupivacaine, and low anesthetic dose (OR 0.69 per mg, p=0.041). Pain during incision (OR 6.72, p=0.002) and emergency surgery (OR 5.11, p=0.007) were also significantly associated with failure.

Conclusion: Spinal anesthesia outcomes are influenced by a combination of patient-related conditions and technical decisions. Recognizing these factors can help tailor anesthesia strategies, reduce failure rates, and enhance procedural safety.

Keywords: Anesthesia Failure, Back Pain, Local Anesthetics, Obesity, Procedural Techniques, Spinal Anesthesia, Surgery.

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INTRODUCTION

Spinal anesthesia, a form of regional block, involves the injection of a local anesthetic into the subarachnoid space, effectively numbing the sensory, motor, and sympathetic nerves temporarily (1,2). This method provides targeted anesthesia by allowing the anesthetic agent to diffuse within the cerebrospinal fluid surrounding the spinal nerve roots. It is widely regarded as the preferred anesthetic technique for surgeries involving the lower limbs, pelvis, and abdomen, including orthopedic, urologic, gynecologic, general, and cesarean section procedures. The advantages of spinal anesthesia include its rapid onset, reliable nerve blockade, and excellent postoperative pain control without the respiratory and gastrointestinal risks associated with general anesthesia, such as pulmonary aspiration (3,4). Despite its clinical benefits, spinal anesthesia is not without limitations. Increasingly, reports have emerged regarding failed spinal anesthesia following proper subarachnoid space injection. Importantly, failure in this context excludes cases where anesthesia was converted to general due to unexpectedly prolonged surgical duration. A failed spinal anesthetic may result in incomplete analgesia, increased operative time, or the need for additional interventions such as repeated dural puncture, which may lead to local anesthetic toxicity or more serious complications like high or total spinal block. Moreover, conversion to general anesthesia during the procedure elevates the risk of respiratory compromise and other systemic complications (5,6). These risks are particularly significant in orthopedic cases, where patient positioning due to pain can hinder successful needle placement, thereby increasing the number of attempts and reducing the success rate. For example, hip fracture surgeries performed with spinal anesthesia in the lateral position often require multiple puncture attempts, contributing to the higher rate of failure (7).

When spinal anesthesia fails, anesthesiologists are presented with limited but critical choices: repeating the spinal block, administering opioids or sedatives, using local infiltration at the surgical site, or shifting to general anesthesia. Each of these alternatives carries its own risk profile, particularly in patients with difficult airways or compromised cardiopulmonary function, and may lead to delays in surgery or increased perioperative complications. While reported failure rates of spinal anesthesia vary widely, ranging from 1% to 17%, this inconsistency is likely due to heterogeneity in patient populations, surgical settings, and the experience levels of the anesthesia providers (8,9). Numerous factors influence the likelihood of spinal anesthesia failure. These include patient demographics such as age, gender, height, and BMI; procedural elements like the vertebral interspace used, needle gauge and type, number of insertion attempts, and whether blood or cerebrospinal fluid is aspirated; as well as anesthetic-related variables including drug baricity, dose, adjuvant use, and the presence of paresthesia during the procedure (10). Positioning during the block and surgeon-induced time pressures further complicate success rates. The consequences of failed spinal anesthesia extend beyond clinical setbacks—they generate considerable anxiety for both patient and anesthetist and may have medico-legal repercussions if recognized only after surgery has begun. This is particularly relevant for trainees, where overconfidence or lack of supervision may compound the risk of failure (11,12).

Potential strategies for mitigating failed spinal anesthesia include reattempting the block under optimal conditions, utilizing systemic analgesics, or converting to general anesthesia if warranted. However, difficulties such as the inability to obtain free cerebrospinal fluid flow during puncture remain common causes of failure. This becomes especially critical in elderly patients, who often present with multiple comorbidities and anatomical changes that complicate spinal access. While spinal anesthesia offers significant advantages for geriatric populations, its limitations and associated risks must be carefully considered (13,14). Although several studies have addressed specific populations, such as obstetric or orthopedic patients, there remains a significant gap in literature analyzing the prevalence and associated risk factors of failed spinal anesthesia across a broader surgical population. Extrapolating data from narrow cohorts to the general surgical setting is problematic due to physiological and procedural differences. Therefore, the objective of this study is to determine the overall prevalence of failed spinal anesthesia and to identify the clinical and procedural factors associated with its occurrence in a diverse surgical patient population.

METHODS

This study employed an analytical cross-sectional design to evaluate the factors associated with failed spinal anesthesia among surgical patients. A total of 175 patients who underwent various surgical procedures under spinal anesthesia were consecutively recruited over a specified period. Eligibility criteria included adult patients aged 18 years and above scheduled for lower abdominal or lower limb

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surgeries. Patients were excluded if they had contraindications to spinal anesthesia, such as coagulopathies, spinal deformities, or known allergies to local anesthetics, or if they required combined or general anesthesia from the outset due to procedural complexity or comorbid conditions. Comprehensive data were collected through a structured proforma that included patient demographics (age, sex), body mass index (BMI), relevant medical history (such as hypertension, diabetes, or prior spinal pathology), and anesthesia-related variables. These included the type and dose of local anesthetic administered, the gauge and type of spinal needle used, the number of puncture attempts required, the anatomical interspace approached, and whether the surgery was elective or emergent in nature. The performance of the spinal block was carried out by experienced anesthesiologists using aseptic techniques in either the sitting or lateral decubitus position, depending on patient condition and surgical requirements. Failure of spinal anesthesia was operationally defined as inadequate sensory or motor block necessitating either repeat spinal puncture, conversion to general anesthesia, or supplementation with systemic analgesics or sedatives.

Ethical approval for the study was obtained from the Institutional Review Board (IRB), and written informed consent was acquired from all participants prior to inclusion. Patient confidentiality and data anonymity were maintained throughout the study in accordance with the Declaration of Helsinki and institutional ethical standards. Statistical analysis was performed using SPSS version 25.0 (IBM Corp., Armonk, NY). Descriptive statistics were reported as means with standard deviations for continuous variables and frequencies with percentages for categorical variables. Logistic regression analysis was conducted to identify independent predictors of failed spinal anesthesia. Variables with a p-value <0.05 in univariate analysis were included in the multivariate model to determine adjusted odds ratios and confidence intervals. All statistical tests were two-tailed, with a significance level set at $p<0.05$.

RESULTS

The study analyzed 175 patients undergoing spinal anesthesia, with a nearly balanced gender distribution (51.4% male, 48.6% female). The most represented ASA class was II (34.3%), followed by Class III (28.6%) and Class I (22.9%). A significant portion of procedures were performed with the patient in the supine position (57.1%). The predominant age group was 46–60 years (31.4%), and the majority of patients were either overweight (34.3%) or obese (20%), with 40% falling in the normal BMI range. The most common height range was 160–169 cm (45.7%). Intraoperative pain during skin incision was absent in 82.9% of patients, indicating a generally high effectiveness of the block. Most surgeries lasted 30–60 minutes (45.7%), with 22.9% lasting less than 30 minutes and 31.4% exceeding one hour. Obstetric and gynecologic surgeries were the most frequent (34.3%), followed by orthopedic (28.6%) and general surgeries (25.7%). Elective procedures accounted for 68.6% of cases, and all spinal anesthetics were administered using hyperbaric solutions. Bupivacaine was the most commonly used local anesthetic (80%), with a 14 mg dose administered in 48.6% of patients. Additives were used in 71.4% of cases, most commonly Toradol and “Nil” (28.6% each). The L4–L5 interspace was the most frequent site of needle insertion (60%).

A Whitacre needle was used in 62.9% of patients, with a 25G gauge being preferred in 68.6% of cases. The spinal block was administered with the patient sitting in 57.1% of cases. Single-attempt skin puncture was achieved in 51.4% of procedures, while the remainder required two or more attempts. Free flow of cerebrospinal fluid (CSF) was confirmed in all cases, and non-bloody CSF was noted in 86.29% of patients. Technical difficulty, such as needle resistance, occurred in 29.14% of cases. Patient-specific challenges included obesity (23.43%), previous spinal surgery (24%), and a history of back pain (33.71%). Overall, spinal anesthesia was successful in 91.43% of patients, with a failure rate of 8.57%. Among the 15 cases of failure, the most common cause was incorrect needle placement (40%), followed by inadequate anesthetic dose (26.67%), patient movement (20%), and anatomical abnormalities (13.33%). Management of failed spinal anesthesia involved conversion to general anesthesia in 40% of cases, repeat spinal block in 26.67%, epidural anesthesia in 20%, and sedation in 13.33%. Postoperative complications included hypotension in 20%, back pain in 19.43%, headache in 12.57%, urinary retention in 10.86%, neurological symptoms in 5.14%, and infection in 3.43%. However, 34.29% of patients reported no complications.

Bivariate analysis revealed no significant association between gender and spinal anesthesia failure ($p = 0.41$). However, failure rates were significantly higher among underweight ($p = 0.02$) and obese patients ($p = 0.02$). Pain during incision strongly predicted failure ($p = 0.001$), as did emergency surgery ($p = 0.035$). The use of Bupivacaine was significantly associated with higher success compared to Lidocaine and Ropivacaine ($p = 0.026$). A 14 mg dose had the highest success, and lower doses (13 mg) were more prone to failure ($p = 0.021$). Use of the Whitacre needle was associated with greater success compared to Quincke ($p = 0.024$), and failure rates increased significantly with multiple puncture attempts ($p = 0.003$). Patient history of back pain, obesity, and previous spine surgery were also

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significantly associated with failure (p = 0.014, 0.006, and 0.003, respectively). Multivariate logistic regression analysis further confirmed several independent predictors. Underweight patients had a 4.76-fold higher risk of failure (p = 0.049), while obesity showed a trend toward increased risk (OR 3.21, p = 0.074). Pain during incision increased failure odds nearly sevenfold (OR 6.72, p = 0.002), and emergency surgery was associated with over five times higher failure risk (OR 5.11, p = 0.007). Use of Lidocaine and Ropivacaine significantly elevated the odds of failure compared to Bupivacaine (ORs 10.5 and 8.4, p = 0.001 and 0.018). Each 1 mg increase in anesthetic dose reduced failure risk by 31% (OR 0.69, p = 0.041). The Quincke needle increased failure risk significantly (OR 3.82, p = 0.027). Attempting skin puncture more than once, particularly three or more times, was associated with very high failure odds (ORs 7.29 and 10.53, p = 0.006 and 0.002). History of back pain, obesity, and prior spine surgery were all significant predictors of failure, with ORs of 6.31, 5.95, and 9.14 respectively (p < 0.005 for all).

Table 1: Demographic and Clinical Characteristics of the Study Population

Variable	Category	Frequency	Percentage
Gender	Male	90	51.40%
	Female	85	48.60%
ASA Class	I	40	22.90%
	II	60	34.30%
	III	50	28.60%
	IV	25	14.20%
Position of Patient	Supine	100	57.10%
	Lithotomy	75	42.90%
Age Group (years)	18–30	35	20.00%
	31–45	50	28.60%
	46–60	55	31.40%
	61+	35	20.00%
BMI Category	Underweight (<18.5)	10	5.70%
	Normal (18.5–24.9)	70	40.00%
	Overweight (25–29.9)	60	34.30%
	Obese (≥30)	35	20.00%
Height Group (cm)	<150	10	5.70%
	150–159	35	20.00%
	160–169	80	45.70%
	170–179	40	22.90%
	180+	10	5.70%

Table 2: Surgical and Anesthetic Characteristics of the Study Population

Variable	Category	Frequency	Percentage
Pain During Incision	Yes	30	17.10%
	No	145	82.90%
Duration of Surgery	<30 minutes	40	22.90%
	30–60 minutes	80	45.70%
	>60 minutes	55	31.40%
Type of Surgery	Obstetric/Gynecology	60	34.30%
	General Surgery	45	25.70%
	Orthopedic	50	28.60%
	Urology	20	11.40%

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Variable	Category	Frequency	Percentage
Urgency of Surgery	Elective	120	68.60%
	Emergency	55	31.40%
Local Anesthetic Used	Bupivacaine	140	80.00%
	Lidocaine	25	14.30%
	Ropivacaine	10	5.70%
Dose (mg)	13 mg	40	22.90%
	14 mg	85	48.60%
	15 mg	50	28.60%
Baricity	Hyperbaric	175	100.00%
Name of Additives	Toradol	50	28.60%
	Tramal + Gravinate	40	22.90%
	Nalbuphine	35	20.00%
	Nil (no additive)	50	28.60%
Level of Needle Insertion	L4–L5	105	60.00%
	L3–L4	70	40.00%

Table 3: Spinal Anesthesia Technique and Patient-related Factors (n = 175)

Variable	Category	Frequency	Percentage
Type of Needle Used	Whitacre	110	62.90%
	Quincke	65	37.10%
Needle Gauge	25G	120	68.60%
	27G	55	31.40%
Patient Position at Time of Injection	Sitting Position	100	57.10%
	Lateral Position	75	42.90%
Skin Puncture Attempts	Once	90	51.40%
	Twice	45	25.70%
	Thrice	25	14.30%
	>3 Times	15	8.60%
Loss of Sensation	Yes	175	100.00%
Confirmation of Arachnoid Space (CSF)	Present (Free Flow)	175	100.00%
CSF Characteristics	Non-bloody	151	86.29%
	Bloody	24	13.71%
Difficulty Encountered	Resistance	51	29.14%
	Nil	124	70.86%
Obesity	Yes	41	23.43%
	No	134	76.57%
Previous Spine Surgery	Yes	42	24.00%
	No	133	76.00%
Back Pain History	Present	59	33.71%
	Absent	116	66.29%
Result of Spinal Anesthesia	Successful	160	91.43%
	Failed	15	8.57%

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Table 4: Causes, Management, and Complications of Failed Spinal Anesthesia

Cause of Failure	Frequency	Percentage (%)
Incorrect needle placement	6	40.00%
Inadequate drug dose	4	26.67%
Anatomical abnormalities	2	13.33%
Patient movement	3	20.00%
Management of Failed Anesthesia		
General anesthesia	6	40.00%
Repeat spinal	4	26.67%
Epidural anesthesia	3	20.00%
Sedation	2	13.33%
Complication		
Headache	22	12.57%
Back pain	34	19.43%
Hypotension	35	20.00%
Neurological symptoms	9	5.14%
Infection	6	3.43%
Urinary retention	19	10.86%
None	60	34.29%

Table 5: Association Between Patient and Procedural Factors and Success or Failure of Spinal Anesthesia

Variable	Category	Success (n = 160)	Failure (n = 15)	Total	p-value
Gender	Male	82	8	90	0.41
	Female	78	7	85	
BMI Category	Underweight	7	3	10	0.02
	Normal	68	2	70	
	Overweight	55	5	60	
	Obese	30	5	35	
Pain During Incision	Yes	20	10	30	0.001
	No	140	5	145	
Urgency of Surgery	Elective	115	5	120	0.035
	Emergency	45	10	55	
Local Anesthetic Used	Bupivacaine	135	5	140	0.026
	Lidocaine	18	7	25	
	Ropivacaine	7	3	10	
Dose (mg)	13 mg	32	8	40	0.021
	14 mg	82	3	85	
	15 mg	46	4	50	
Needle Type	Whitacre	105	5	110	0.024
	Quincke	55	10	65	
Puncture Attempts	Once	90	0	90	0.003
	Twice	42	3	45	
	Thrice	18	7	25	
	>3 times	10	5	15	

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Variable	Category	Success (n = 160)	Failure (n = 15)	Total	p-value
Back Pain History	Present	48	11	59	0.014
	Absent	112	4	116	
Obesity	Yes	30	11	41	0.006
	No	130	4	134	
Previous Spine Surgery	Yes	30	12	42	0.003
	No	130	3	133	

Table 6: Multivariate Logistic Regression Analysis of Factors Associated with Failure of Spinal Anesthesia

Variable	Category (Reference)	Odds Ratio (OR)	95% CI	p-value
Gender	Male (ref)	0.91	0.32 – 2.58	0.865
BMI Category	Normal (ref)			
	Underweight	4.76	1.01 – 22.49	0.049
	Overweight	1.54	0.38 – 6.26	0.544
	Obese	3.21	0.89 – 11.56	0.074
Pain During Incision	No (ref)	6.72	2.01 – 22.44	0.002
Urgency of Surgery	Elective (ref)	5.11	1.55 – 16.84	0.007
Local Anesthetic Used	Bupivacaine (ref)			
	Lidocaine	10.5	2.75 – 40.03	0.001
	Ropivacaine	8.4	1.43 – 49.45	0.018
Dose (per 1 mg increase)	Continuous (13–15 mg)	0.69	0.48 – 0.98	0.041
Needle Type	Whitacre (ref)	3.82	1.17 – 12.43	0.027
Skin Puncture Attempts	Once (ref)			
	Twice	2.5	0.46 – 13.70	0.291
	Thrice	7.29	1.77 – 30.12	0.006
	>3 Times	10.53	2.31 – 47.91	0.002
Back Pain History	Absent (ref)	6.31	1.89 – 21.03	0.003
Obesity	No (ref)	5.95	1.73 – 20.43	0.005
Previous Spine Surgery	No (ref)	9.14	2.45 – 34.13	0.001

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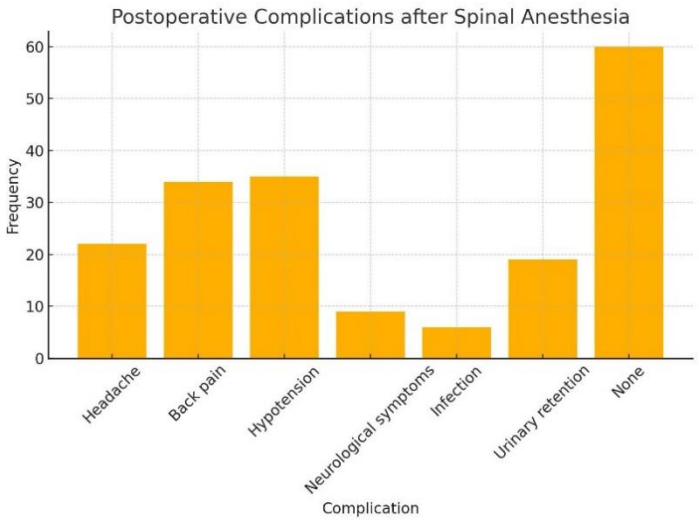

Figure 1 Postoperative Complication after Spinal Anesthesia

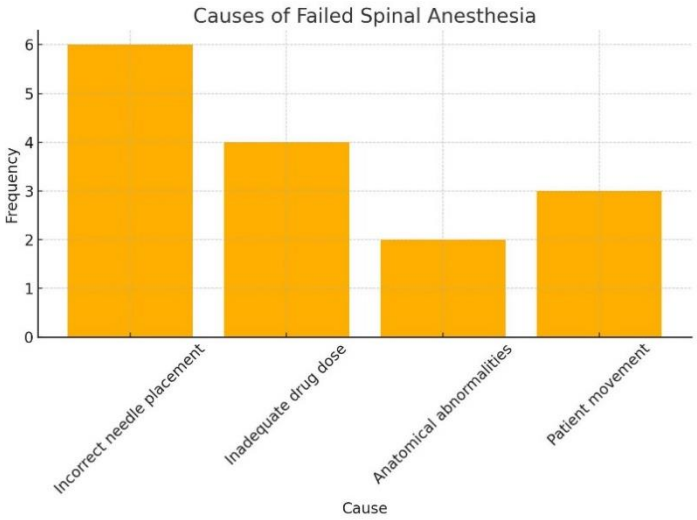

Figure 2 Cases of Failed Spinal Anesthesia

DISCUSSION

The findings of this study reinforce the reliability of spinal anesthesia as a preferred anesthetic technique for surgeries involving the lower abdomen and extremities, yet they also underscore the persistent issue of failure in a subset of cases. The overall failure rate observed in this cohort was 8.57%, which aligns with previously reported ranges of 1% to 17% in broader literature (1,14,15). However, this figure remains lower than failure rates documented in some regional studies, such as those conducted in Ethiopia, where incidences of failed spinal anesthesia reached up to 22.4% in comprehensive hospitals and 19.5% among obstetric parturients (13,14). The discrepancy may reflect differences in practitioner experience, patient demographics, procedural standardization, or institutional resources (15,16). It is noteworthy that teaching hospitals, which often involve trainees in anesthesia administration, may contribute to elevated failure rates due to variability in technique and clinical judgment. The association between spinal anesthesia failure and specific surgical categories in this study mirrored trends seen in previous investigations (17). Higher failure rates were observed in cesarean sections, gynecologic, orthopedic, and urologic surgeries. These procedures are often performed under challenging conditions—such as emergent settings or on patients with compromised anatomy or limited positional tolerance due to pain or advanced age (18). The technical complexity associated with lumbar puncture in such scenarios, particularly in uncooperative patients or those experiencing labor or fracture-related discomfort, could reduce the success rate. Previous studies have also noted that anatomical distortion, such as uterine enlargement in obstetric cases or degenerative spine changes in elderly patients, interferes with accurate needle placement and proper drug dispersion (19,20).

A key determinant of failure in this and other studies was the incorrect placement of the spinal needle, despite confirmation of cerebrospinal fluid (CSF) flow. This observation suggests that visual confirmation of CSF is not alone a reliable indicator of effective intrathecal drug delivery. Factors such as intrathecal drug leakage, incomplete distribution, or misdirection of the injectate may compromise the blockade, even when the technical steps appear correct. These findings support earlier assertions that spinal anesthesia can fail due to mechanical and pharmacological issues unrelated to initial procedural success indicators (21,22). Furthermore, the likelihood of spinal anesthesia failure was significantly elevated during emergency surgeries, where time constraints, poor patient cooperation, and suboptimal resource availability may hinder precision. Rapid initiation of surgical incision before full anesthetic onset in emergency scenarios further exacerbates this risk (23). The intrathecal dose of local anesthetic, particularly bupivacaine, played a pivotal role in determining the success of spinal anesthesia. The study found that doses less than 10 mg were significantly associated with higher failure rates, a pattern consistently reported in previous literature and supported by findings from multicenter cohort studies and meta-analyses (24). Inadequate dosing impairs anesthetic spread across the necessary dermatomes, especially for procedures requiring high sensory blockade such as cesarean sections. Moreover, insufficient drug volume can result in asymmetric or patchy blocks, requiring intraoperative analgesic supplementation or conversion to general anesthesia. It is well established that the efficacy of

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spinal anesthesia hinges not only on correct needle placement but also on appropriate dosing strategies tailored to the patient's physiologic and procedural demands.

This study's strength lies in its comprehensive analysis of both patient-specific and procedural variables across a representative surgical population. Unlike previous investigations limited to single-surgery types or demographic groups, this research offers broader applicability by encompassing various surgical specialties and patient risk profiles. Additionally, the use of multivariate logistic regression enabled the identification of independent predictors of spinal anesthesia failure, enhancing the clinical utility of the findings. However, several limitations must be acknowledged. The study was conducted in a single institutional setting, potentially limiting generalizability. Additionally, inter-operator variability, although inherent in real-world practice, was not standardized or stratified, which could have influenced outcomes. There was also no follow-up beyond the immediate postoperative period to assess for delayed neurological complications or long-term outcomes of failed spinal anesthesia. Furthermore, data regarding anesthesia provider experience, spinal needle redirections, or the use of imaging guidance were not incorporated, despite their relevance to procedural accuracy. Future studies should aim to incorporate multicenter designs with larger, stratified samples to evaluate institutional and provider-level factors contributing to spinal anesthesia failure. The integration of ultrasonography for spinal level localization and real-time drug dispersion assessment could offer valuable insights into minimizing technical failures. Additionally, protocol-driven approaches to anesthetic dosing and adjuvant use, along with enhanced training and supervision in teaching environments, may further improve outcomes. In conclusion, this study highlights that while spinal anesthesia remains an effective and widely used technique, failure is multifactorial and influenced by both modifiable and non-modifiable factors. A careful preoperative assessment, proper technique, adequate dosing, and awareness of patient-related challenges are critical to optimizing spinal anesthesia success and minimizing the need for intraoperative conversion or postoperative complications.

CONCLUSION

This study concludes that the success of spinal anesthesia is intricately linked to a combination of patient-specific factors and technical execution. Elements such as body habitus, spinal history, and intraoperative conditions can significantly influence outcomes, while the choice of needle, anesthetic agent, dosing, and precision of technique also play critical roles. Recognizing these risk factors and adapting the anesthetic approach accordingly can help reduce failure rates and enhance patient safety. These findings highlight the importance of individualized patient assessment, careful procedural planning, and skilled administration in ensuring effective and reliable spinal anesthesia.

AUTHOR CONTRIBUTION

Author	Contribution
Hazrat Ali	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Asad Ullah	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Khush Noor	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Nadeem Ullah Khan	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Shahzaib	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Maheen Najeeb*	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Alam Zeb	Contributed to study concept and Data collection Has given Final Approval of the version to be published

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