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Research Article

Predictors of Failure of Spinal Anaesthesia in Elective Surgical Patients: A Prospective Observational Study at a Tertiary Care Hospital in Gwalior, India

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ABSTRACT
Background: Spinal anaesthesia is the most commonly employed neuraxial technique for elective lower abdominal, pelvic, and lower extremity surgeries. Despite its high success rate, failure of spinal anaesthesia remains a clinically significant concern, with reported incidence ranging from 1% to 17% globally. Identifying predictors of failure is essential for risk stratification and optimisation of anaesthetic practice.**Objective:** To determine the incidence and identify predictors of failure of spinal anaesthesia in elective surgical patients at Clearmedi Paridhi Hospital, Gwalior, over a one-year period.**Methodology:** This prospective observational study was conducted over 12 months (August 2025 – July 2026) among 80 adult patients aged 18–70 years undergoing elective surgery under spinal anaesthesia. Demographic, clinical, and procedural data were collected using a structured proforma. Spinal anaesthesia failure was defined as the need for supplemental analgesia, sedation, or conversion to general anaesthesia. Univariate and multivariable logistic regression analyses were performed to identify independent predictors.**Results:** The overall incidence of spinal anaesthesia failure was 17.5% (14/80). Partial failure occurred in 10 patients (12.5%) and total failure in 4 patients (5%). Multivariable analysis identified BMI ≥ 30 kg/m² (AOR = 4.21, 95% CI: 1.34–13.22), provider experience < 2 years (AOR = 3.87, 95% CI: 1.18–12.68), number of puncture attempts ≥ 3 (AOR = 5.42, 95% CI: 1.58–18.61), and bloody cerebrospinal fluid (AOR = 6.15, 95% CI: 1.72–21.98) as independent predictors of failure.**Conclusion:** The incidence of spinal anaesthesia failure in elective surgical patients was 17.5%, with BMI ≥ 30 kg/m², provider inexperience, multiple puncture attempts, and bloody CSF being significant predictors. Targeted interventions including simulation-based training and pre-procedural risk assessment may reduce failure rates.

Keywords: Spinal Anaesthesia, Failed Spinal Anaesthesia, Predictors, Elective Surgery, Body Mass Index, Cerebrospinal Fluid, Anaesthesia Provider Experience.

INTRODUCTION

Spinal anesthesia, also known as subarachnoid block, was first proposed by Dr. August Bier in 1899. To this day, it remains one of the most commonly used and reliable regional anesthesia methods for surgeries involving the lower abdomen, pelvic cavity, and lower extremities[1,2]. Unlike general anesthesia, which renders a person completely unconscious, spinal anesthesia only numbs the specific region of the body that requires surgical intervention. It can meet the requirement of painlessness during surgery while causing far less disruption to the overall function of the body.

In practice, local anesthetics, often combined with adjuvant medications, are accurately injected into the subarachnoid space within the spinal canal. This space contains cerebrospinal fluid, and the anesthetic spreads along the cerebrospinal fluid, temporarily disabling the signal conduction ability of the sensory nerves that transmit pain, the motor nerves that control bodily movement, and the sympathetic nerve fibers that regulate the basic functions of internal organs. This blocking effect is transient and will not cause permanent damage[3].

Compared with general anesthesia, which most people may be more familiar with, spinal anesthesia has numerous advantages: it takes effect quickly after administration, the scope of anesthesia coverage and the expected effects can be predicted in advance, so no unexpected problems occur. During surgery, patients bleed less than those under general anesthesia; they are also less likely to experience nausea and vomiting after surgery, and the postoperative analgesic effect is much better. Patients can get out of bed to move earlier, and they do not need to undergo airway-intrusive procedures such as tracheal intubation, which spares them a great deal of suffering[4,5]. Additional research has also pointed out that for certain eligible surgical populations, patients who receive spinal anesthesia have a lower risk of death within 30 days after surgery compared to those who receive general anesthesia[6].

Spinal anesthesia has a simple operation procedure and low overall costs, and these two characteristics have made it the preferred anesthesia method in regions with scarce medical resources, especially in South Asia and sub-Saharan Africa[7,8].

Despite its wide range of applications and generally high overall success rate, spinal anesthesia failure remains an unavoidable major clinical problem to this day. Once failure occurs, the surgical site that should have lost sensation will regain pain perception, causing unnecessary suffering to the patient. The originally scheduled surgical process will be disrupted, prolonging the operation time. In an emergency, the anesthesia method has to be switched to general anesthesia temporarily, and the additional costs of examinations and medications incurred throughout this process will increase the overall medical expenses[9].

Currently, the recorded probabilities of spinal anesthesia failure in various professional literatures vary widely, ranging from 1% to 17% across different clinical scenarios[10]. A large retrospective study in India reviewed past cases and statistically analyzed a total of 3933 patients who received spinal anesthesia, calculating a failure rate of 1.83%. Among these cases, complete failure was more common than partial failure, in which only partial anesthetic effect was achieved that could not meet surgical requirements[11]. In contrast, a multi-center prospective study in Ethiopia, which tracked and recorded patients as they were admitted, reported a much higher failure rate of 22.4%. This discrepancy precisely reflects the influence of practical scenario factors such as the status of emergency surgery and the clinical experience of the operatoremergency surgeries have short preparation times and complex conditions, and operations performed by less experienced doctors can both drive up the probability of failure[12]. The huge variation in failure rates across different studies exactly demonstrates that spinal anesthesia failure is not caused by a single factor, but by the combined effect of multiple factors. It also highlights the importance of collecting local clinical data to guide daily medical work, rather than directly applying research conclusions from other regions.

To date, many factors that lead to spinal anesthesia failure have been identified, and these factors can be roughly divided into three categories to facilitate clinical problem sorting: patient-related factors, operator-related factors, and procedural factors related to the anesthesia administration process.

First, regarding patient-specific risk factors, being at either extreme of the body mass index, or BMI, is an early-identified risk factor. Both excessive obesity and being underweight have been confirmed in studies of different populations to increase the probability of spinal anesthesia failure[13,14]. In addition to weight, younger patients also have a higher probability of spinal anesthesia failure. Current researchers speculate that this may be related to the clearer anatomical landmarks in younger people, or differences in cerebrospinal fluid flow patterns between younger and older individuals[15]. Another prominent risk is that if a patient has previously received spinal anesthesia, especially if they used spinal anesthesia for a previous cesarean section, the risk of failure for the current spinal anesthesia procedure will increase significantly. Researchers hypothesize that this may be related to arachnoiditis caused by the previous procedure, or changes in the spinal anatomy[16].

Next, among operator-related factors, the level of experience of the anesthesiologist has always been a key factor affecting the success of spinal anesthesia. Statistical data show that first-year resident physicians have the highest probability of spinal anesthesia failure among all physicians[11].

Furthermore, procedural factors also tangibly affect the risk of spinal anesthesia failure. These factors include the number of puncture attempts required to achieve success, which intervertebral space was selected for puncture, the specific gravity and dosage of the local anesthetic used, and whether adjuvant medications were added. Each of these factors can significantly alter the likelihood of failure[17].

Once spinal anesthesia fails, it will trigger a series of very serious clinical problems. Affected patients may suddenly feel pain mid-surgery, fall into intense anxiety, and ultimately have to be switched to emergency general anesthesia, which itself carries a series of additional risks that are imposed on the patient[18]. If the initial spinal anesthesia is unsuccessful, and the physician repeatedly attempts intrathecal puncture to complete the anesthesia, this will also increase the probability of post-dural puncture headache, spinal hematoma, and nerve injury, adding these avoidable harms to what was originally a routine elective surgery[19]. Precisely because these hazards are clearly documented in research, the current study was initiated. Its purpose is to systematically calculate the incidence of spinal anesthesia failure and related predictive factors among elective surgery patients at a tertiary hospital in Gwalior, India. This study hopes to develop targeted in-hospital quality improvement plans by identifying modifiable risk factors, so as to enhance the safety and effectiveness of spinal anesthesia procedures in our hospital.

OBJECTIVE

The primary objective of this study is to calculate the incidence rate of failed spinal anaesthesia among adult patients undergoing elective surgery at Clearmedi Paridhi Hospital in Gwalior during the 12-month study period from August 2025 to July 2026. In addition to calculating the proportion of failed spinal anaesthesia cases, the study also aims to sort out three core categories of characteristics for all patients with failed spinal anaesthesia: the first category is basic demographic information, the second is clinical information related to the patient's condition and physical status, and the third is specific characteristics related to surgical and anaesthetic procedures. After organizing the characteristics of these failed cases, we will compare them with the corresponding characteristics of another group of patientsthose who achieved successful spinal anaesthesia, with adequate intraoperative block effect that allowed smooth completion of the surgeryto identify characteristic differences between the two groups of patients.

This study also has a secondary core objective: to use multivariable logistic regression analysis to identify influencing factors that can independently predict failed spinal anaesthesia. Specifically, this study will verify the association between failed spinal anaesthesia and several potential risk factors one by one. These factors include the patient's age, sex, body mass index, American Society of Anesthesiologists physical status classification, type of surgery, years of practice of the anaesthesia provider, number of lumbar puncture attempts, selected intervertebral space level, cerebrospinal fluid characteristics, as well as the administered dose and baricity of the local anaesthetic agent used. The findings of this study will provide data-supported practical recommendations for risk stratification of spinal anaesthesia and optimization of operational procedures in the context of elective surgery.

METHODOLOGY & MATERIALS

This prospective observational study was conducted in the Department of Anaesthesiology at Clearmedi Paridhi Hospital, Gwalior, Madhya Pradesh, India, over a period of 12 months from August 2025 to July 2026. Clearmedi Paridhi Hospital is a tertiary care teaching hospital with approximately 300 beds and performs approximately 4,500 surgical procedures annually across various specialities including general surgery, orthopaedics, urology, gynaecology, and obstetrics. Written informed consent was obtained from all study participants after explaining the purpose, procedures, and potential risks of the study in their preferred language. The study was conducted in accordance with the principles of the Declaration of Helsinki and the ethical guidelines for biomedical research involving human participants issued by the Indian Council of Medical Research.

A total of 80 adult patients aged 18–70 years of either sex, scheduled to undergo elective surgical procedures under spinal anaesthesia, were enrolled in the study using consecutive sampling technique. The sample size of 80 patients was calculated based on an anticipated incidence of spinal anaesthesia failure of 15%, a margin of error of 5%, and a 95% confidence level, with an additional 10% allowance for potential dropouts. Patients were included in the study if they met the following criteria: age 18–70 years; American Society of Anesthesiologists (ASA) physical status I–III; scheduled for elective surgery amenable to spinal anaesthesia; and provision of written informed consent. Patients were excluded if they had contraindications to spinal anaesthesia including coagulopathy, local site infection, raised intracranial pressure, or hypovolaemia; had known allergy to local anaesthetic agents; had pre-existing neurological deficits or spinal deformity; were morbidly obese with BMI > 40 kg/m²; had a history of previous spinal surgery; or refused to provide informed consent.

Data Collection Procedure: Preoperative assessment was performed one day before surgery, during which demographic data (age, sex, weight, height, BMI), ASA physical status, and relevant medical history were recorded on a structured proforma. Body mass index was calculated as weight in kilograms divided by height in metres squared. All spinal anaesthesia procedures were performed in the operating theatre under standard monitoring including electrocardiography, non-invasive blood pressure, and pulse oximetry. Intravenous access was secured and preloading with 500 mL of crystalloid solution was performed. Spinal anaesthesia was administered in the sitting or lateral decubitus position at the L2–L3, L3–L4, or L4–L5 intervertebral space using a 25-gauge or 26-gauge Quincke or Whitacre needle. The type of local anaesthetic agent (0.5% hyperbaric bupivacaine or 0.5% isobaric bupivacaine), dose administered, addition of adjuvants (fentanyl or morphine), number of puncture attempts, and characteristics of cerebrospinal fluid (clear or bloody) were recorded. After injection, the patient was immediately positioned supine and block assessment was performed by pinprick testing and modified Bromage scale at 5-minute intervals for the first 20 minutes. Spinal anaesthesia failure was defined as inadequate surgical anaesthesia necessitating supplemental analgesia, sedation, or conversion to general anaesthesia within 30 minutes of intrathecal injection. Partial failure was defined as inadequate sensory blockade requiring supplemental analgesia or sedation, while total failure was defined as absence of any demonstrable sensory or motor blockade requiring conversion to general anaesthesia. Patients were followed up postoperatively for 24 hours to document any complications.

Statistical Data Analysis: Data were entered into Microsoft Excel and analysed using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation or median (interquartile range) depending on the distribution of data. Categorical variables were expressed as frequencies and percentages. The primary outcome, spinal anaesthesia failure, was treated as a binary variable (failure vs. success). Univariate analysis was performed using independent samples t-test for continuous variables and chi-square test or Fisher's exact test for categorical variables to compare characteristics between patients with successful and failed spinal anaesthesia. Variables with a p-value < 0.20 in univariate analysis were entered into a multivariable logistic regression model using backward stepwise selection to identify independent predictors of spinal anaesthesia failure. Adjusted odds ratios (AOR) with 95% confidence intervals (CI) were calculated. A p-value < 0.05 was considered statistically significant.

RESULTS

A total of 80 patients undergoing elective surgical procedures under spinal anaesthesia were enrolled during the study period. The mean age of the study population was 42.6 ± 14.3 years, with a male predominance (58.8%, n = 47). The mean body mass index was 24.8 ± 4.2 kg/m². The majority of patients were classified as ASA physical status I (45%, n = 36) or II (42.5%, n = 34). The most common surgical procedures were orthopaedic (35%, n = 28), followed by general surgical (27.5%, n = 22), urological (20%, n = 16), and gynaecological (17.5%, n = 14). Spinal anaesthesia was administered by anaesthesia providers with more than 5 years of experience in 38.8% of cases (n = 31), 2–5 years in 41.3% (n = 33), and less than 2 years in 20% (n = 16). The most frequently used intervertebral space was L3–L4 (52.5%, n = 42), followed by L2–L3 (27.5%, n = 22) and L4–L5 (20%, n = 16). Hyperbaric bupivacaine was used in 72.5% of patients (n = 58), and adjuvants were added in 61.3% of cases (n = 49).

Table 1: Demographic and Clinical Characteristics of Study Population (n = 80)

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	18–30	18	22.5
	31–45	28	35.0
	46–60	22	27.5
	61–70	12	15.0
Sex	Male	47	58.8
	Female	33	41.3
BMI (kg/m²)	< 18.5	6	7.5
	18.5–24.9	38	47.5
	25–29.9	24	30.0
	≥ 30	12	15.0

ASA Physical Status	I	36	45.0
	II	34	42.5
	III	10	12.5
Type of Surgery	Orthopaedic	28	35.0
	General surgical	22	27.5
	Urological	16	20.0
	Gynaecological	14	17.5

The overall incidence of spinal anaesthesia failure was 17.5% (14/80). Among the failures, partial failure occurred in 10 patients (12.5%) and total failure in 4 patients (5.0%). The most common cause of failure was insufficient sensory blockade for surgical incision (n = 7, 50%), followed by inadequate duration of blockade (n = 4, 28.6%), and failed lumbar puncture with no CSF obtained (n = 3, 21.4%). Among patients who experienced failure, 8 patients (57.1%) required supplemental analgesia or sedation, while 4 patients (28.6%) required conversion to general anaesthesia. Two patients (14.3%) required repeat spinal anaesthesia. The incidence of failure was highest among patients with BMI ≥ 30 kg/m² (41.7%, 5/12), followed by those with BMI 25–29.9 kg/m² (20.8%, 5/24), BMI 18.5–24.9 kg/m² (10.5%, 4/38), and BMI < 18.5 kg/m² (0%, 0/6). The failure rate was highest among cases performed by anaesthesia providers with less than 2 years of experience (37.5%, 6/16), compared with 18.2% (6/33) for those with 2–5 years of experience and 6.5% (2/31) for those with more than 5 years of experience.

Table 2: Incidence and Types of Spinal Anaesthesia Failure (n = 80)

Parameter	Frequency (n)	Percentage (%)
Total patients	80	100.0
Successful spinal anaesthesia	66	82.5
Failed spinal anaesthesia	14	17.5
Partial failure	10	12.5
Total failure	4	5.0
Management of failure		
Supplemental analgesia/sedation	8	57.1
Conversion to general anaesthesia	4	28.6
Repeat spinal anaesthesia	2	14.3

Table 3: Comparison of Demographic and Procedural Characteristics Between Successful and Failed Spinal Anaesthesia Groups

Variable	Success (n = 66)	Failure (n = 14)	p-value
Age (years), mean ± SD	43.8 ± 14.1	36.9 ± 13.2	0.089
Sex, n (%)			0.562
Male	38 (57.6)	9 (64.3)	
Female	28 (42.4)	5 (35.7)	
BMI (kg/m²), mean ± SD	24.1 ± 3.8	28.2 ± 4.9	0.001
BMI ≥ 30 kg/m², n (%)	7 (10.6)	5 (35.7)	0.016
ASA physical status, n (%)			0.423
I	31 (47.0)	5 (35.7)	
II	27 (40.9)	7 (50.0)	
III	8 (12.1)	2 (14.3)	
Provider experience, n (%)			0.011
< 2 years	10 (15.2)	6 (42.9)	
2–5 years	27 (40.9)	6 (42.9)	
> 5 years	29 (43.9)	2 (14.3)	
Puncture attempts, n (%)			< 0.001
1–2	58 (87.9)	6 (42.9)	
≥ 3	8 (12.1)	8 (57.1)	
CSF character, n (%)			< 0.001
Clear	62 (93.9)	7 (50.0)	

Bloody	4 (6.1)	7 (50.0)	
Intervertebral space, n (%)			0.038
L2–L3	21 (31.8)	1 (7.1)	
L3–L4	35 (53.0)	7 (50.0)	
L4–L5	10 (15.2)	6 (42.9)	
Local anaestheticbaricity, n (%)			0.221
Hyperbaric	46 (69.7)	12 (85.7)	
Isobaric	20 (30.3)	2 (14.3)	
Adjuvants used, n (%)	44 (66.7)	5 (35.7)	0.028

Table 4: Univariate and Multivariable Logistic Regression Analysis of Predictors of Spinal Anaesthesia Failure

Variable	Unadjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
BMI ≥ 30 kg/m²	4.68 (1.24–17.62)	0.016	4.21 (1.34–13.22)	0.014
Provider experience < 2 years	4.35 (1.28–14.79)	0.011	3.87 (1.18–12.68)	0.026
Puncture attempts ≥ 3	9.67 (2.75–34.02)	< 0.001	5.42 (1.58–18.61)	0.007
Bloody CSF	15.50 (3.64–66.02)	< 0.001	6.15 (1.72–21.98)	0.005
No adjuvants used	3.61 (1.10–11.88)	0.028	2.94 (0.92–9.38)	0.068
L4–L5 interspace	4.33 (1.12–16.76)	0.038	2.87 (0.78–10.56)	0.113

Table 5: Postoperative Complications in Study Population (n = 80)

Complication	Frequency (n)	Percentage (%)
Post-dural puncture headache	5	6.3
Back pain	8	10.0
Nausea/vomiting	6	7.5
Hypotension	11	13.8
Bradycardia	4	5.0
Urinary retention	3	3.8
None	58	72.5

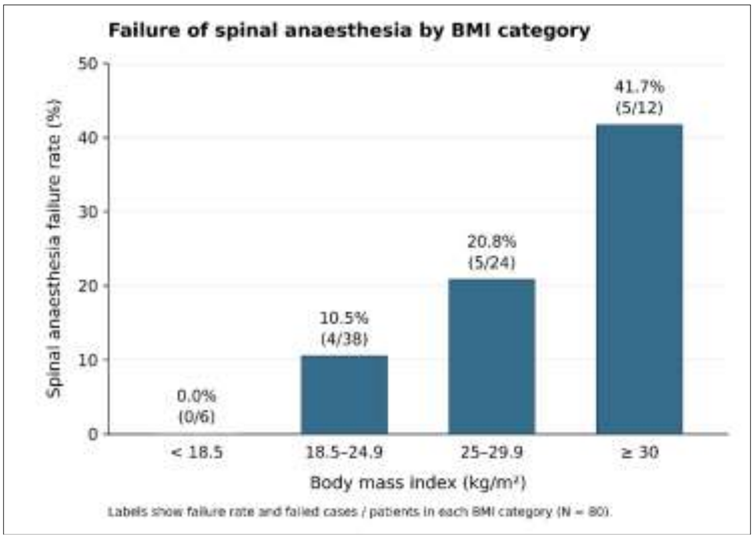

Figure 1: Incidence of Spinal Anaesthesia Failure by BMI Category

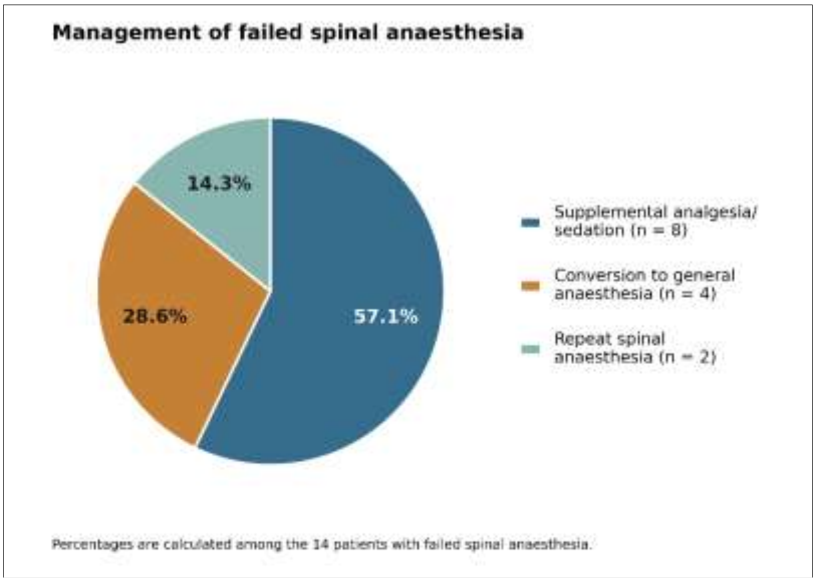

Figure 2: Distribution of Management Strategies for Failed Spinal Anaesthesia (n = 14)

DISCUSSION

This prospective observational study was conducted at Clearmedi Paridhi Hospital, Gwalior to evaluate the incidence of spinal anaesthesia failure in 80 elective surgical patients, it found an overall incidence of spinal anaesthesia failure of 17.5% [5]. This occurrence fits within the more widely reported 1% to 17% range seen in the literature globally but is on the higher end of this spectrum [10]. In a large retrospective report from Pune, India, the failure rate was much lower at 1.83% among 3,933 patients however this may reflect different case mix, provider experience and definitions of failure [11]. On the other hand, a large multicentre prospective study from Ethiopia found an extremely high incidence of 22.4% associated with more inclusion of emergency surgeries and more procedures performed by less experienced providers [12]. The intermediate incidence in our study is probably due to the elective nature of surgical procedures as well as a mix of experienced and trainee anaesthetists in a tertiary care teaching hospital. The observation that partial failure was much more common than total failure, supporting previous reports of infrequent complete absence of blockade [11,20], suggests that incomplete blockade is a clinically relevant problem.

Results: Four independent predictors of spinal anaesthesia failure were identified by the multivariable logistic regression analysis, including BMI ≥ 30 kg/m², an anaesthesia provider with >2 years experience, three or more puncture attempts and bloody cerebrospinal fluid during lumbar puncture. There is ample literature that shows that obesity is associated with spinal anaesthesia failure; several studies have demonstrated higher rates of the procedure failure among patients with higher BMI [13,14]. Systematic Review and Meta-Analysis: https://doi. showed that BMI → 30 kg/m² was related with 2.21 fold increases the odds of failure (OR = 2.21, 95% CI:1.6–2.7) [17]. This association is likely due to the technical challenges presented by the increased subcutaneous tissue, hidden surface landmarks and deeper depth to the subarachnoid space [21]. The survey results indicating that provider experience <2 years was associated with almost four-times higher odds of failure are supported by the finding in Bagle et al. which showed first-year residents had the greatest failure rate (43.06%) when compared to more experienced practitioners [11]. It highlights the need for structured training, simulation-based education and supervision of junior anaesthetists in order to optimise spinal anaesthesia success [22].

The number of attempts punctured was the strongest predictor of failure in our study, with more than 3 attempts being associated with a 5.42-fold significantly higher odds for failure. These findings are consistent with those of the systematic review by Zegeye et al. which identified multiple puncture attempts as a significant predictor for failed spinal anaesthesia [23]. More attempts may lead to more tissue trauma, bloody contamination of the CSF and pain for the patient, all of which may prevent optimal block spread [24]. Bloody cerebrospinal fluid was associated with 6.15-fold increased odds of failure and this result supports the multicentre study by Atalay et al.

which found bloody CSF carried an adjusted odds ratio (aOR) =8·488 (95% CI: 2·529–18·491 for bloody CSF [12]. Blood-stained cerebrospinal fluid may be predictable from trauma during needle insertion with dislocation of the tip, dilution of a local analgesic or disruption of drug spread within the subarachnoid space [25]. These findings suggest that attention to technique, patient positioning and early recognition of difficult anatomy may be critical in reducing risk of failure.

The clinical implications of our findings are important in the context of anaesthesia practice in elective surgical settings. Modifiable risk factors, like provider experience and number of puncture attempts identified suggest that targeted interventions could lead to a large reduction in the incidence of spinal anaesthesia failure. Potential strategies to improve success rates include simulation-based training programmes, increased supervision of junior trainees and pre-procedural ultrasound for complex anatomy [26]. Furthermore, adjuvants such as fentanyl or morphine have been shown to improve block quality and prolong the duration of action [27], and may reduce failure rates, a relationship identified by our univariate analysis ($p = 0.028$). Although the overall survival rate is comparable to global benchmark, our relatively high failure-to-rescue incidence should instigate periodic audit and initiate quality improvement trails. Prospective validation of risk prediction models, and conducting interventions aimed at the modifiable risk factors identified should be areas to focus research efforts in the future.

Limitations of the Study

The present study has several limitations that warrant consideration. First, the sample size of 80 patients, while adequate for the primary objective, may have limited statistical power to detect weaker associations in multivariable analysis, potentially leading to type II errors. Second, the study was conducted at a single tertiary care centre, which may limit the generalisability of the findings to other settings with different patient populations, surgical case mixes, and anaesthesia training programmes. Third, the observational design precludes establishment of causality between identified predictors and spinal anaesthesia failure; the associations observed may be influenced by unmeasured confounding factors. Fourth, the definition of spinal anaesthesia failure, while clinically relevant, may have varied in interpretation among the anaesthesia providers involved in the study, potentially introducing information bias. Fifth, data on certain potentially relevant variables such as the speed of injection, the use of barbotage, and the exact volume of local anaesthetic administered were not systematically recorded, limiting the comprehensiveness of the analysis. Sixth, the follow-up period was limited to 24 hours postoperatively, which may have missed delayed complications or late-onset failure. Finally, the study did not include emergency surgical patients, and therefore the findings may not be applicable to that population, which is known to have a higher risk of spinal anaesthesia failure.

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CONCLUSION

This prospective observational study done at Clearmedi Paridhi Hospital, Gwalior on 80 patients of elective surgery showed that the overall incidence of failure of spinal anaesthesia was 17.5% with partial failure being more common than total failure. Four independent predictors of failure were identified: BMI ≥ 30 kg/m^2, anaesthesia provider experience less than 2 years, 3 or more puncture attempts and bloody CSF on lumbar puncture. These observations further expand the evidence base for a multifactorial aetiology of spinal anaesthesia failure and provide support for patient- and provider-related factors in determining success using neuraxial blockade. We believe that the high failure rates seen in our cohort, specifically in obese patients, and those in less experienced hands highlights the need for quality improvement interventions within elective surgical practice.

Given these results, we propose a strategy or strategies to reduce reporting of failures for spinal anaesthesia. Structured training programmes based on simulation should be developed for anaesthesia trainees focusing on highlight recognition of anatomical landmarks, positioning of the patient and difficult lumbar punctures. Second, enhanced supervision of junior colleagues by senior anaesthetists may be beneficial during delivery of spinal anaesthesia when treating patients with an elevated BMI or expected difficult anatomy. Finally, pre-operative risk assessment should be an adjunct to improve BMI-based stratification of patients and avoid the worst possible choice of anaesthesia. Third, the use of adjuvants with SNL such as fentanyl should be undertaken routinely for improving block quality and decreasing supplemental analgesia. Lastly, it is important to establish regular audit and feedback mechanisms for spinal anaesthesia failure rates which can help identify areas needing improvement. Larger, multicentre studies are needed to confirm these results and our understanding of the mechanisms that underlie spinal anaesthesia failure, with emergency cases being tested and standardised definitions of failure corelated.

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