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Reported Failure Proportion, Characteristics, and Perioperative Consequences of Failed Spinal Anesthesia: A One-Year Prospective Descriptive Study at Mohammed V Military Teaching Hospital, Rabat

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AUTHORS AND AFFILIATION

Ahmed FAKRI, Maha Sekkal , Youssef Halhoul , Mourad Ababou , Marouane Jidal , Abderrahmane Elwali, Mustapha Bensghir

Anesthesia and Critical Care, HOPITAL MILITAIRE D'INSTRUCTION MOHAMED V, Rabat, Morocco

Corresponding author: Ahmed FAKRI .

ABSTRACT

Introduction

Spinal anesthesia is widely used for lower abdominal, pelvic, obstetric, urological, and lower-limb orthopedic procedures. Although it is considered a reliable neuraxial technique, failure may occur and can lead to intraoperative pain, intravenous analgesic supplementation, conversion to general anesthesia, surgical delay, postoperative complications, and patient dissatisfaction. Data regarding failed spinal anesthesia in Morocco remain limited. This study aimed to determine the reporting-based failure proportion, characteristics, and perioperative consequences of failed spinal anesthesia at Mohammed V Military Teaching Hospital, Rabat.

Methods

We conducted a single-center prospective descriptive observational study over a one-year period from April 2025 to April 2026. Failed spinal anesthesia cases were voluntarily reported by anesthesia providers using a standardized electronic Google Forms questionnaire whenever a failure was recognized. The denominator was obtained from institutional operating room activity records. Because individual-level data on successful spinal anesthesia

procedures were not collected, the analysis was primarily descriptive and cannot identify independent predictors reported in the literature. The reported failure proportion and key outcomes are presented with 95% confidence intervals where appropriate. Data were analyzed using Jamovi version 2.2.5.

Results

A total of 120 failed spinal anesthesia cases were reported among 4,012 spinal anesthesia procedures, corresponding to a reporting-based failure proportion of 3.0% (95% CI, 2.5-3.6%). Of these, 115 (95.8%) cases had complete analyzable data. Partial failure was observed in 65 (56.5%; 95% CI, 47.4-65.2%) cases, total failure in 44 (38.3%; 95% CI, 29.9-47.4%), and unclear or inconsistent responses in six (5.2%). Intraoperative pain occurred in 97 (84.3%; 95% CI, 76.6-89.9%) cases, intravenous analgesic supplementation was required in 96 (83.5%; 95% CI, 75.6-89.2%), and conversion to general anesthesia occurred in 56 (48.7%; 95% CI, 39.8-57.7%) failed cases. Orthopedic surgery, cesarean section, and urological surgery were the most frequently represented surgical categories among reported failed cases. These frequencies should not be interpreted as comparative risk estimates because successful spinal anesthesia cases were not characterized at the individual level.

Conclusion

In this one-year prospective descriptive study, 120 failed spinal anesthesia cases were reported among 4,012 spinal anesthesia procedures, corresponding to a reporting-based proportion of 3.0%. Partial failure, intraoperative pain, analgesic supplementation, surgical delay, and conversion to general anesthesia were common among reported failures. Because case identification relied on voluntary provider reporting and successful spinal anesthesia procedures were not characterized, this estimate should not be interpreted as the definitive institutional incidence, and the observed associations should be considered exploratory only.

KEYWORDS :

Failed spinal anesthesia; spinal anesthesia failure; regional anesthesia; intraoperative pain; conversion to general anesthesia; Morocco; military teaching hospital; perioperative outcomes; spinal block failure; anesthetic complications.

MAIN ARTICLE

INTRODUCTION

Spinal anesthesia is a central neuraxial anesthetic technique that produces a temporary blockade of sensory, motor, and sympathetic nerve transmission through the injection of local anesthetic, with or without adjuvant drugs, into the subarachnoid space [1]. Since its introduction into clinical practice by August Bier in 1899, spinal anesthesia has become one of the most widely used regional anesthesia techniques because of its rapid onset, reliable sensory and motor block, relative technical simplicity, and favorable safety profile [1,2]. It is commonly used for lower abdominal, urological, gynecological, obstetric, and lower-limb orthopedic procedures, and remains particularly valuable in high-volume surgical settings and resource-limited environments [2-4].

Compared with general anesthesia, spinal anesthesia offers several potential advantages, including avoidance of airway manipulation, reduced opioid requirements, lower incidence of postoperative nausea and vomiting, improved postoperative analgesia, reduced intraoperative blood loss in selected procedures, earlier ambulation, shorter post-anesthesia care unit stay, and faster recovery in appropriately selected patients [5-8]. In obstetric anesthesia, it is widely preferred for cesarean delivery because it provides rapid and dense surgical anesthesia while avoiding several maternal and neonatal risks associated with general anesthesia [9]. In orthopedic and urological surgery, spinal anesthesia has also been associated with favorable postoperative outcomes in several comparative studies [5-8].

Despite these advantages, spinal anesthesia is not universally successful. Failed spinal anesthesia remains a clinically significant problem because it may lead to inadequate surgical anesthesia, intraoperative pain, patient anxiety, anesthesiologist stress, surgical delay, repeated neuraxial puncture, intravenous analgesic or sedative supplementation, or conversion to general anesthesia [10,11]. Reported failure rates vary widely in the literature, ranging from approximately 1% to 17%, depending on the study population, type of surgery, definition of failure, provider experience, and institutional practice [3,4,9,12]. This wide variation also reflects the lack of a uniform definition of failed spinal anesthesia, which may include complete absence of block, inadequate sensory level, patchy or unilateral block, insufficient duration of anesthesia, intraoperative pain, need for supplemental analgesia, repeat spinal anesthesia, or conversion to general anesthesia [9-12].

The mechanisms of spinal anesthesia failure are multifactorial. Patient-related factors may include obesity, difficult anatomical landmarks, kyphoscoliosis, chronic low back pain,

narrow lumbar canal, previous spinal surgery, or variations in cerebrospinal fluid volume [10,13]. Technical factors include inappropriate needle placement, absence of free cerebrospinal fluid flow before injection, traumatic or bloody tap, multiple puncture attempts, use of a lower lumbar interspace such as L4-L5, inadequate local anesthetic dose, inappropriate baricity, and errors in drug preparation or injection [10,12-15]. Provider-related factors, particularly limited experience with neuraxial techniques, may also influence the probability of success [3,4,13]. Surgical factors such as emergency procedures, prolonged operative duration, and the need for a high sensory level may further increase the risk of block inadequacy [3,9,12].

The consequences of failed spinal anesthesia extend beyond technical failure. Intraoperative pain during regional anesthesia is a major patient safety and quality-of-care issue. It may negatively affect patient satisfaction, increase perioperative anxiety, and expose patients to urgent conversion to general anesthesia under suboptimal conditions [10,11]. Repeated neuraxial puncture may increase the risk of post-dural puncture headache, back pain, neurological symptoms, or patient discomfort, while conversion to general anesthesia may be associated with additional respiratory and hemodynamic risks, particularly in emergency or high-risk patients [10,11,16]. Therefore, identifying the clinical and technical circumstances associated with failed spinal anesthesia is essential for improving prevention, early recognition, and appropriate management.

Although failed spinal anesthesia has been studied in obstetric and non-obstetric populations in several countries, local data from Morocco and North Africa remain scarce. Institutional evaluation is important because the frequency and management of failed spinal anesthesia may vary according to surgical case mix, emergency workload, training level of anesthesia providers, availability of senior supervision, technical habits, and organizational factors. Mohammed V Military Teaching Hospital in Rabat is a high-volume tertiary care center where 12,100 surgical procedures were performed during the study period, including 4,012 procedures under spinal anesthesia. This setting provides an appropriate opportunity to evaluate failed spinal anesthesia in real-life daily practice.

The present study aimed to estimate the reporting-based proportion of failed spinal anesthesia and to describe the clinical characteristics, management, and perioperative consequences of reported failed cases over a one-year period at Mohammed V Military Teaching Hospital, Rabat, Morocco. The study was not designed to establish causal predictors of failure because individual-level data from successful spinal anesthesia procedures were not collected.

MATERIALS AND METHODS

Study design and setting

This was a single-center, prospective, descriptive observational study conducted at Mohammed V Military Teaching Hospital in Rabat, Morocco, over a one-year period from April 2025 to April 2026. The manuscript was prepared in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology, STROBE, recommendations for observational studies [17]. The study was designed to estimate the reporting-based proportion of failed spinal anesthesia and to describe the characteristics, management, and perioperative consequences of reported failed cases in routine surgical practice.

Mohammed V Military Teaching Hospital is a tertiary care teaching hospital with high-volume surgical activity. During the study period, 12,100 surgical procedures were performed, including 4,012 procedures conducted under spinal anesthesia. The total number of spinal anesthesia procedures was obtained from institutional operating room activity records and was used only as the denominator for calculating a reporting-based failure proportion. It was not used to compare individual risk factors because patient-level data for successful spinal anesthesia procedures were unavailable.

Case identification and reporting mechanism

Potential failed spinal anesthesia cases were identified only when an anesthesia provider recognized an inadequate block and completed the electronic form. The study did not include active surveillance of every spinal anesthesia procedure, systematic review of anesthesia records, or direct observation by an independent investigator. This reporting mechanism was pragmatic for a hospital-wide quality evaluation but introduces a risk of selection bias and underreporting. Therefore, the denominator was used to calculate a reporting-based proportion, not to establish a definitive incidence or causal risk model.

Ethical considerations

The study was approved by the local institutional ethics committee of Mohammed V Military Teaching Hospital, Rabat, Morocco. Approval number: [INSERT APPROVAL NUMBER]. Because the study was observational, involved anonymized data collection, and did not modify patient management, the requirement for individual written informed consent was

waived by the ethics committee. Data were collected anonymously through a standardized electronic form, without recording patient-identifying information. All perioperative management decisions were left to the discretion of the attending anesthesia team.

Study population and definitions

The study population included patients who experienced a recognized failed spinal anesthesia event during the study period and whose cases were reported through the standardized electronic data collection form. Patients were eligible if surgery was initially planned or started under spinal anesthesia and subsequently developed total or partial inadequacy of the block. Cases were excluded if the anesthetic technique was not spinal anesthesia from the outset, if combined spinal-epidural anesthesia was used and the failure could not be attributed specifically to the spinal component, if essential data regarding failure type or perioperative management were missing, if the reported event was unrelated to spinal anesthesia failure, or if a contraindication to spinal anesthesia had been identified before the procedure.

Failed spinal anesthesia was defined as any spinal block that did not allow the surgical procedure to be completed under adequate surgical anesthesia without additional anesthetic intervention. For case capture, this umbrella definition included total failure, partial failure, intraoperative pain requiring treatment, inadequate sensory block, need for intravenous analgesic or sedative supplementation, repeat spinal anesthesia, or conversion to general anesthesia. However, these manifestations were not considered clinically equivalent; therefore, total failure, partial failure, conversion to general anesthesia, and analgesic supplementation were reported separately whenever possible.

Total failure was defined as absence of clinically effective sensory and/or motor block after intrathecal injection, inability to achieve a sufficient block for surgical incision, or need for conversion to general anesthesia because of ineffective spinal anesthesia. Partial failure was defined as an incomplete, insufficient, unilateral, patchy, short-lasting, or inadequate spinal block that allowed surgery to continue only after additional measures such as intravenous analgesic supplementation, sedation, local anesthetic infiltration by the surgeon, waiting for further block extension, or other supportive anesthetic interventions.

Data collection and variables

Data were collected prospectively using a standardized electronic questionnaire created with Google Forms. The form was completed by anesthesia providers whenever a failed spinal anesthesia event was recognized. No independent observer, daily operating room screening, or systematic reconciliation with anesthesia charts was implemented. Therefore, underreporting is possible, particularly for minor, borderline, rapidly corrected, or undocumented events. The questionnaire collected patient-related, surgical, provider-related, technical, intraoperative, postoperative, and satisfaction-related variables.

Patient-related variables included age, sex, body mass index category, American Society of Anesthesiologists physical status classification, and anatomical or spinal risk factors such as kyphoscoliosis, chronic low back pain, narrow lumbar canal, previous spinal surgery, or absence of known anatomical risk factors. The American Society of Anesthesiologists physical status classification was used to describe preoperative patient status [18].

Surgical variables included surgical specialty, elective or emergency status, estimated or actual surgical duration, and timing of surgery. Surgical specialty was categorized as cesarean section, urological surgery, orthopedic surgery, digestive surgery, gynecological surgery, or other. Surgical duration was categorized as less than 30 minutes, 30-60 minutes, or more than 60 minutes. Timing of surgery was categorized as daytime, nighttime, weekend, or public holiday. Provider-related variables included the level of anesthesia provider experience, categorized as intern, resident, specialist, or senior anesthesiologist.

Technical variables included patient position during spinal anesthesia, intervertebral space used, type and gauge of spinal needle, number of puncture attempts, intrathecal anesthetic agents used, and highest sensory level achieved. Intrathecal drugs included hyperbaric bupivacaine, isobaric bupivacaine, ropivacaine, intrathecal morphine, fentanyl, sufentanil, or combinations.

Intraoperative outcomes included intraoperative pain, need for intravenous analgesic supplementation, conversion to general anesthesia, intraoperative complications, type of spinal anesthesia failure, and surgical delay greater than 10 minutes related to the failure. Intraoperative complications included hypotension, bradycardia, vasovagal episode, respiratory difficulty, agitation, asymmetric block, or absence of complication. Postoperative outcomes included post-dural puncture headache, urinary retention, persistent low back pain,

transient neurological symptoms, infection at the puncture site, meningeal syndrome, absence of postoperative complication, and postoperative admission to the intensive care unit.

Patient satisfaction and anesthesia provider satisfaction with failure management were assessed using a five-point Likert-type categorical scale ranging from very satisfied to very dissatisfied [19].

Outcomes

The primary outcome was the reporting-based proportion of failed spinal anesthesia during the one-year study period. It was calculated by dividing the number of reported failed spinal anesthesia cases by the total number of spinal anesthesia procedures performed during the same period. Because reporting depended on provider completion of the form, this proportion should be interpreted as a reported failure proportion rather than a definitive institutional incidence. Secondary outcomes included the distribution of partial and total failures, intraoperative pain, intravenous analgesic supplementation, conversion to general anesthesia, perioperative complications, postoperative complications, postoperative intensive care admission, surgical delay greater than 10 minutes, and satisfaction outcomes.

Statistical analysis

Data were exported from Google Forms into Microsoft Excel and checked for completeness and consistency before analysis. Statistical analysis was performed using Jamovi version 2.2.5. Categorical variables were expressed as number and percentage, N (%), and selected proportions were presented with 95% confidence intervals. Quantitative variables were expressed as mean +/- standard deviation when normally distributed, or median and range when appropriate. Because individual-level successful spinal anesthesia cases were not collected, no multivariable model of predictors reported in the literature was performed. Exploratory comparisons were restricted to factors associated with conversion to general anesthesia among reported failed cases, using the chi-square test or Fisher's exact test as appropriate. A p-value <0.05 was considered statistically significant for exploratory purposes only.

RESULTS

During the one-year study period, 12,100 surgical procedures were performed at Mohammed V Military Teaching Hospital, Rabat, including 4,012 procedures under spinal anesthesia. A total of 120 failed spinal anesthesia cases were reported, corresponding to a reporting-based failure proportion of 3.0% (95% CI, 2.5-3.6%). Of these, 115 (95.8%; 95% CI, 90.6-98.2%) cases had complete analyzable data.

The mean age of patients was 46.9 ± 15.0 years, with a median age of 45 years and a range from 21 to 87 years. Male patients represented 60 (52.2%) cases, while female patients represented 55 (47.8%). Most patients were classified as ASA II, 69 (60.0%), while ASA I and ASA III each represented 23 (20.0%) cases. Regarding body mass index, 40 (34.8%) patients were normal weight, 34 (29.6%) were overweight, and 40 (34.8%) had obesity class I or higher. Baseline characteristics are summarized in Table 1.

TABLE 1: Study population, reported failure proportion, and baseline characteristics

Variable	Value / n	% / Description
Total surgical procedures during the study period	12,100	—
Total spinal anesthesia procedures	4,012	—
Reported failed spinal anesthesia cases	120	3.0% reporting-based proportion (95% CI, 2.5-3.6%)
Analyzable failed spinal anesthesia cases	115	95.8% of reported failures
Age, years	46.9 ± 15.0	Median: 45; range: 21-87
Male sex	60	52.2%
Female sex	55	47.8%
ASA I	23	20.0%
ASA II	69	60.0%
ASA III	23	20.0%

Variable	Value / n	% / Description
BMI <18.5 kg/m²	1	0.9%
BMI 18.5-24.9 kg/m²	40	34.8%
BMI 25-29.9 kg/m²	34	29.6%
BMI 30-34.9 kg/m²	22	19.1%
BMI 35-39.9 kg/m²	12	10.4%
BMI ≥40 kg/m²	6	5.2%

Note: Continuous variables are expressed as mean +/- standard deviation, with median and range when available. Categorical variables are expressed as number and percentage. The 3.0% estimate is a reporting-based proportion derived from voluntarily reported failures. ASA: American Society of Anesthesiologists; BMI: body mass index.

No anatomical or spinal risk factor was reported in 64 (55.7%) cases. The most frequently reported anatomical or spinal conditions were chronic low back pain in 22 (19.1%) cases, narrow lumbar canal in 13 (11.3%), kyphoscoliosis in 11 (9.6%), and previous spinal surgery in six (5.2%), as shown in Table 2.

TABLE 2: Anatomical or spinal risk factors among failed spinal anesthesia cases

Anatomical or spinal factor	**n**	**%**
No anatomical risk factor	64	55.7%
Chronic low back pain	22	19.1%
Narrow lumbar canal	13	11.3%
Kyphoscoliosis	11	9.6%
Previous spinal surgery	6	5.2%
Other	2	1.7%

Note: Multiple answers were possible for anatomical factors; therefore, percentages may exceed 100%.

Orthopedic surgery was the most frequent surgical category among failed spinal anesthesia cases, accounting for 30 (26.1%) cases, followed by cesarean section in 27 (23.5%),

urological surgery in 23 (20.0%), gynecological surgery in 19 (16.5%), and digestive surgery in 16 (13.9%). Most procedures were elective, 71 (61.7%), while emergency procedures accounted for 44 (38.3%) cases. Surgical duration was 30-60 minutes in 60 (52.2%) cases and more than 60 minutes in 45 (39.1%). Most cases occurred during daytime working hours, 82 (71.3%). Regarding provider-related characteristics, failed spinal anesthesia cases were most frequently reported among procedures performed by specialists, 47 (40.9%), followed by residents, 41 (35.7%), senior anesthesiologists, 16 (13.9%), and interns, 11 (9.6%). Surgical and provider-related characteristics are presented in Table 3.

TABLE 3: Surgical and provider-related characteristics of failed spinal anesthesia cases

Variable	n	%
Type of surgery		
Cesarean section	27	23.5%
Orthopedic surgery	30	26.1%
Urological surgery	23	20.0%
Gynecological surgery	19	16.5%
Digestive surgery	16	13.9%
Nature of surgery		
Elective	71	61.7%
Emergency	44	38.3%
Surgical duration		
<30 minutes	9	7.8%
30-60 minutes	60	52.2%
>60 minutes	45	39.1%
Mixed response	1	0.9%
Timing of surgery		
Daytime, 08h-20h	82	71.3%
Nighttime, 20h-08h	25	21.7%
Weekend or public holiday	5	4.3%
Nighttime plus weekend/public holiday	3	2.6%

Variable	n	%
Anesthesia provider level		
Intern	11	9.6%
Resident	41	35.7%
Specialist	47	40.9%
Senior anesthesiologist	16	13.9%

Spinal anesthesia was performed in the sitting position in 94 (81.7%) cases and in the lateral decubitus position in 21 (18.3%). The most frequently used intervertebral space was L3-L4 in 50 (43.5%) cases, followed by L4-L5 in 33 (28.7%) and L2-L3 in 16 (13.9%). A Quincke needle was used in 100 (87.0%) cases, while pencil-point needles were used in 13 (11.3%). The most frequently used needle gauge was 25G in 80 (69.6%) cases, followed by 27G in 31 (27.0%). More than one puncture attempt was frequent, with two to three attempts in 52 (45.2%) cases and more than three attempts in 35 (30.4%). Hyperbaric bupivacaine was used in 103 (89.6%) cases, fentanyl in 101 (87.8%), intrathecal morphine in 30 (26.1%), and isobaric bupivacaine in 12 (10.4%). Technical characteristics are shown in Table 4.

TABLE 4: Technical characteristics of spinal anesthesia among failure cases

Variable	n	%
Patient position		
Sitting position	94	81.7%
Lateral decubitus	21	18.3%
Intervertebral space		
L2-L3	16	13.9%
L3-L4	50	43.5%
L4-L5	33	28.7%
Not specified	12	10.4%
Multiple levels selected	4	3.5%
Needle type		
Quincke	100	87.0%

Variable	n	%
Pencil-point	13	11.3%
Missing	2	1.7%
Needle gauge		
25G	80	69.6%
26G	4	3.5%
27G	31	27.0%
Number of attempts		
One attempt	28	24.3%
Two to three attempts	52	45.2%
More than three attempts	35	30.4%
Intrathecal drugs used		
Hyperbaric bupivacaine	103	89.6%
Isobaric bupivacaine	12	10.4%
Intrathecal morphine	30	26.1%
Fentanyl	101	87.8%
Sufentanil	1	0.9%

Note: Intrathecal drugs and some intervertebral space responses allowed multiple selections; therefore, percentages may not sum to 100%.

After clinical recoding, partial failure was observed in 65 (56.5%; 95% CI, 47.4-65.2%) cases, total failure in 44 (38.3%; 95% CI, 29.9-47.4%), and unclear or inconsistent responses in six (5.2%; 95% CI, 2.4-10.9%). Intraoperative pain was reported in 97 (84.3%; 95% CI, 76.6-89.9%) cases, and intravenous analgesic supplementation was required in 96 (83.5%; 95% CI, 75.6-89.2%). Conversion to general anesthesia occurred in 56 (48.7%; 95% CI, 39.8-57.7%) failed spinal anesthesia cases, corresponding to 1.4% (95% CI, 1.1-1.8%) of all spinal anesthesia procedures performed during the study period. A delay in the surgical procedure greater than 10 minutes occurred in 83 (72.2%; 95% CI, 63.4-79.5%) cases. Type of failure and intraoperative management are summarized in Table 5.

TABLE 5: Type of failure and intraoperative management

Outcome	n	%
Partial failure	65	56.5%
Total failure	44	38.3%
Unclear or inconsistent response	6	5.2%
Intraoperative pain	97	84.3%
IV analgesic supplementation	96	83.5%
Conversion to general anesthesia	56	48.7%
Surgical delay >10 minutes	83	72.2%

Note: Short-duration block, limited-duration block, asymmetric block, and early regression of block were clinically recoded as partial failures. Six responses were inconsistent or unclear. The broad umbrella definition was used for case capture, but failure subtypes and management consequences are reported separately to avoid treating all events as clinically equivalent.

At least one intraoperative complication was reported in 79 (68.7%) cases. The most frequent intraoperative complication was hypotension in 44 (38.3%) cases, followed by asymmetric block in 20 (17.4%), agitation in 18 (15.7%), bradycardia in 13 (11.3%), vasovagal episode in eight (7.0%), and respiratory difficulty in eight (7.0%).

Postoperative complications were absent in 61 (53.0%) cases. The most frequent postoperative events were persistent low back pain in 27 (23.5%) cases, post-dural puncture headache in 16 (13.9%), urinary retention in 14 (12.2%), and transient neurological symptoms in one (0.9%). Postoperative intensive care admission occurred in 23 (20.0%) cases.

Patient satisfaction was negatively affected. Overall, 53 (46.1%) patients were dissatisfied or very dissatisfied, 30 (26.1%) were neutral, and 32 (27.8%) were satisfied or very satisfied. Regarding anesthesiologist satisfaction with the management of spinal anesthesia failure, 44 (38.3%) were dissatisfied or very dissatisfied, 28 (24.3%) were neutral, and 43 (37.4%) were satisfied or very satisfied. Perioperative complications and satisfaction outcomes are presented in Table 6.

TABLE 6: Perioperative complications, ICU admission, and satisfaction outcomes

Outcome	n	%
Intraoperative complications		
No intraoperative complication	36	31.3%
Hypotension	44	38.3%
Asymmetric block	20	17.4%
Agitation	18	15.7%
Bradycardia	13	11.3%
Vasovagal episode	8	7.0%
Respiratory difficulty	8	7.0%
Other	1	0.9%
Postoperative complications		
No postoperative complication	61	53.0%
Persistent low back pain	27	23.5%
Post-dural puncture headache	16	13.9%
Urinary retention	14	12.2%
Transient neurological symptoms	1	0.9%
Other	2	1.7%
Postoperative outcome		
Postoperative ICU admission	23	20.0%
Patient satisfaction		
Very satisfied	5	4.3%
Satisfied	27	23.5%
Neutral	30	26.1%
Dissatisfied	43	37.4%
Very dissatisfied	10	8.7%
Anesthesiologist satisfaction with failure management		
Very satisfied	7	6.1%
Satisfied	36	31.3%
Neutral	28	24.3%

Outcome	n	%
Dissatisfied	37	32.2%
Very dissatisfied	7	6.1%

Note: Complication items allowed multiple selections; therefore, percentages may not sum to 100%.

In exploratory analysis limited to reported failed spinal anesthesia cases, conversion to general anesthesia was more frequent in total failures than in partial failures. Among total failures, 43 of 44 (97.7%) cases required conversion to general anesthesia, compared with 13 of 65 (20.0%) partial failures. Conversion was also more frequent among cases with more than three puncture attempts, procedures lasting more than 60 minutes, ASA III status, digestive and orthopedic procedures, surgical delay greater than 10 minutes, and postoperative intensive care admission. These analyses describe factors associated with conversion after a failure had occurred; they do not identify independent predictors reported in the literature. Exploratory variables associated with conversion to general anesthesia are shown in Table 7.

TABLE 7: Exploratory variables associated with conversion to general anesthesia among failed spinal anesthesia cases

Variable	Category	Conversion to GA, n/N	%	p-value
Failure type	Partial failure	13/65	20.0%	<0.001
Failure type	Total failure	43/44	97.7%	<0.001
Number of attempts	One attempt	7/28	25.0%	<0.001
Number of attempts	Two to three attempts	19/52	36.5%	<0.001
Number of attempts	More than three attempts	30/35	85.7%	<0.001
Surgical duration	<30 minutes	1/9	11.1%	<0.001
Surgical duration	30-60 minutes	18/60	30.0%	<0.001
Surgical duration	>60 minutes	36/45	80.0%	<0.001
ASA status	ASA I	9/23	39.1%	0.006
ASA status	ASA II	29/69	42.0%	0.006

Variable	Category	Conversion to GA, n/N	%	p-value
ASA status	ASA III	18/23	78.3%	0.006
Type of surgery	Cesarean section	8/27	29.6%	<0.001
Type of surgery	Orthopedic surgery	21/30	70.0%	<0.001
Type of surgery	Urological surgery	10/23	43.5%	<0.001
Type of surgery	Gynecological surgery	4/19	21.1%	<0.001
Type of surgery	Digestive surgery	13/16	81.2%	<0.001

Note: This is an exploratory analysis among failed spinal anesthesia cases only. It identifies variables associated with conversion to general anesthesia after failure, not independent predictors of spinal anesthesia failure, because no successful spinal anesthesia control group was included.

Discussion

Spinal anesthesia is widely considered one of the most reliable regional anesthesia techniques, but inadequate block remains clinically relevant because it may lead to intraoperative pain, additional anesthetic intervention, conversion to general anesthesia, surgical delay, and dissatisfaction. In the present one-year prospective descriptive study, 120 failed spinal anesthesia cases were reported among 4,012 spinal anesthesia procedures at Mohammed V Military Teaching Hospital, Rabat, corresponding to a reporting-based proportion of 3.0%. Among the 115 analyzable reported failures, partial failure was more frequent than total failure, intraoperative pain was common, and conversion to general anesthesia occurred in 56 (48.7%) failed cases.

Before interpreting these findings, an important methodological limitation must be emphasized. Failed cases were identified through voluntary provider reporting rather than systematic surveillance of all spinal anesthesia procedures. Minor, borderline, or rapidly corrected failures may therefore have been underreported. In addition, successful spinal anesthesia procedures were not characterized at the individual level. Consequently, the 3.0% figure should be interpreted as a reporting-based proportion rather than a definitive

institutional incidence, and the clinical variables described in this manuscript should not be interpreted as causal predictors of failure.

The reporting-based proportion observed in our study falls within the broad range reported in previous studies, although direct comparison remains difficult because definitions of failed spinal anesthesia, data collection methods, and surgical populations vary substantially. It is higher than the 1.83% reported by Bagle et al. in an Indian university hospital but lower than the pooled global incidence of 8.36% reported by Zegeye et al. in their systematic review and meta-analysis [20,21]. It is also lower than the 19.64% incidence reported by Ashagrie et al. among patients undergoing cesarean section in Ethiopia [12]. Differences may reflect heterogeneity in surgical populations, definitions of failure, provider experience, emergency workload, documentation practices, and active versus passive case ascertainment.

TABLE 8: Comparison of reported failed spinal anesthesia proportions across studies

Study	**Country / Setting**	**Population**	**Study design**	**Total spinal anesthesia cases**	**Failed spinal anesthesia cases**	Reported failure proportion
Current study	Morocco, Mohammed V Military Teaching Hospital, Rabat	Mixed surgical population	Prospective observational, single-center	4,012	120 reported; 115 analyzable	3.0%
Bagle et al., 2024 [20]	India, university hospital	Mixed surgical population	Prospective observational	3,933	72	1.83%
Sng et al., 2009 [9]	Singapore	Elective cesarean section	Prospective cohort	800	4 total failures; 37 partial failures	0.5% total failure; 4.6% partial failure

Study	Country / Setting	Population	Study design	Total spinal anesthesia cases	Failed spinal anesthesia cases	Reported failure proportion
Ashagrie et al., 2020 [12]	Ethiopia	Cesarean section	Prospective observational	275	54	19.64%
Zegeye et al., 2026 [21]	Systematic review and meta-analysis	Mixed populations	Meta-analysis of 21 studies	44,790	2,134	8.36% pooled incidence
Fettes et al., 2009 [10]	Review	Mixed surgical population	Narrative review	NA	NA	Reported range varied; failure may involve extent, quality, or duration of block

The distribution of failure types in our study differs from that reported by Bagle et al., who found that most failures were total failures [20]. In our cohort, partial failure represented 65 (56.5%) analyzable cases, whereas total failure represented 44 (38.3%). This difference likely reflects the broader and more clinically oriented definition used in our study, where intraoperative pain, incomplete block, asymmetric block, insufficient duration, and need for intravenous analgesia were considered relevant manifestations of failure. This approach is consistent with the conceptual framework proposed by Fettes et al., who considered failure as a problem involving block extent, quality, duration, or patient management, rather than only the absence of sensory or motor block [10]. Differences in failure patterns and management strategies between our study and previous reports are summarized in Table 9.

TABLE 9: Comparison of failure patterns and management strategies

Study	Total failure	Partial failure / supplementation	Conversion to general anesthesia	Main management strategies
Current study	44 (38.3%) of failed cases	65 (56.5%) of failed cases	56 (48.7%) of failed cases; approximately 1.4% of all spinal anesthetics	IV analgesia, sedation, conversion to GA, supportive management
Bagle et al., 2024 [20]	87.5%	12.5%	31.94% of failed cases	Repeat spinal anesthesia, conversion to GA, sedation
Sng et al., 2009 [9]	0.5% of all spinal anesthetics	4.1% required IV fentanyl; 0.9% required Entonox	0.5% of all spinal anesthetics	IV fentanyl, Entonox, conversion to GA
Ashagrie et al., 2020 [12]	Not directly comparable	Supplementation common	5.5% among failed cases	Ketamine sedation, repeated spinal anesthesia, conversion to GA
Fettes et al., 2009 [10]	Variable	Variable	Variable	Repeat injection, posture manipulation, local infiltration, systemic analgesia/sedation, GA

Orthopedic surgery was the most frequent surgical category among reported failed spinal anesthesia cases in our cohort, followed by cesarean section, urological surgery, gynecological surgery, and digestive surgery. This observation should be interpreted as a frequency distribution among failures rather than proof that orthopedic surgery independently increases the risk of failure. Nevertheless, the finding is clinically plausible because orthopedic patients may be difficult to position because of pain, trauma, fractures, or limited mobility. Suboptimal positioning may increase technical difficulty, the number of puncture attempts, and the risk of inadequate block. In the Cureus study by Bagle et al., failures were most frequent by number in obstetric surgery, whereas the highest category-specific failure rate was observed in orthopedic surgery, followed by urological surgery [20].

Emergency procedures accounted for 44 (38.3%) reported failed cases in our study. Because successful spinal anesthesia cases were not collected at the individual level, we cannot estimate the comparative incidence of failure in emergency versus elective surgery in our institution. Published studies have reported higher failure rates in emergency settings, and Zegeye et al. identified emergency surgery as a predictor in pooled analysis [20,21]. In our dataset, emergency status should therefore be viewed as a contextual variable frequently present among reported failures, not as an independently demonstrated risk factor.

Technical difficulty was common among reported failures. More than one puncture attempt was reported in 87 (75.7%) cases, and more than three attempts in 35 (30.4%). These findings cannot determine whether multiple attempts caused failure or reflected difficult anatomy, suboptimal positioning, provider experience, or case complexity. They remain clinically important because repeated attempts may increase patient discomfort, prolong operating room time, increase the risk of traumatic puncture, and negatively affect patient satisfaction. A surgical delay greater than 10 minutes occurred in 83 (72.2%) cases, confirming the organizational impact of recognized failure events.

Provider experience should also be interpreted cautiously. In our study, residents and interns were involved in 52 (45.2%) reported failures. This proportion does not establish that limited experience caused spinal anesthesia failure because the denominator of all spinal anesthetics performed by each provider category was not available. However, previous studies have reported associations between provider experience and failure [20,21]. From a quality-improvement perspective, our findings support the practical value of supervision, progressive autonomy, simulation-based training, and early senior support when technical difficulty is encountered.

TABLE 10: Selected variables discussed in the literature and observed among reported failed spinal anesthesia cases

Note: The current study column describes frequencies among reported failed cases only. It does not estimate comparative incidence, independent risk, or causal predictors because successful spinal anesthesia procedures were not characterized at the individual level.

Factor	Current study	Bagle et al., 2024 [20]	Ashagrie et al., 2020 [12]	Zegeye et al., 2026 meta-analysis [21]	Interpretation
Emergency surgery	44 (38.3%) failed cases	Higher failure in emergency cases: 3.87% vs 1.39% elective	Emergency surgery associated with failure	Emergency surgery significant predictor	Reported among failures; emergency context may increase technical and organizational difficulty, but this study did not estimate independent risk
Provider experience	Residents and interns involved in 52 (45.2%) failures	First-year residents had highest failure rate	Anesthesia provider status associated with failure	Provider inexperience significant predictor	Training and supervision are practical quality-improvement targets; causality was not tested in this study
Number of attempts	>1 attempt in 87 (75.7%); >3 attempts in 35 (30.4%)	Noted as technical issue	Multiple attempts associated with failure	Number of attempts included among important factors	Multiple attempts may reflect technical difficulty and may worsen patient experience; causality was not tested
BMI / obesity	BMI ≥30 in 40 (34.8%) failed cases	Discussed as relevant	Obesity associated in literature	BMI ≥30 significant predictor	Obesity may impair landmarks and positioning; this study reports frequency among failures only

Factor	Current study	Bagle et al., 2024 [20]	Ashagrie et al., 2020 [12]	Zegeye et al., 2026 meta-analysis [21]	Interpretation
L4-L5 puncture	33 (28.7%) failed cases	Mostly L3-L4 in their cohort	L4-L5 associated in literature	L4-L5 significant predictor	Lower interspace may influence block spread or reflect technical difficulty; not tested causally here
CSF flow / bloody CSF	Not collected	Clear free CSF documented	Bloody CSF associated with failure	Bloody CSF and absence of free CSF flow significant predictors	Should be added to future forms
Local anesthetic dose	Not collected exactly	Heavy bupivacaine used	Low volume associated with failure	Dose/baricity significant predictors	Exact dose in mg should be mandatory in future studies
Type of surgery	Orthopedic most common among failures, 30 (26.1%)	Obstetric most common by number; orthopedic highest rate	Cesarean section population	Mixed populations, orthopedic and mixed surgical groups important	Surgical population affects the profile of reported failures and should be captured in future comparative studies

The high frequency of intraoperative pain in our study is one of the most clinically important findings. Intraoperative pain occurred in 97 (84.3%) failed cases, and intravenous analgesic supplementation was required in 96 (83.5%). This confirms that failed spinal anesthesia is not merely a technical issue but a patient safety and quality-of-care problem. In the obstetric cohort by Sng et al., partial failure was defined by the need for intraoperative analgesic supplementation, such as intravenous fentanyl or Entonox, and total failure was defined by conversion to general anesthesia [9]. Our findings extend this concern to a broader mixed

surgical population and show that intraoperative pain has a major impact on patient experience, with 53 (46.1%) patients reporting dissatisfaction or very high dissatisfaction.

Conversion to general anesthesia occurred in 56 (48.7%) failed cases. This proportion should not be interpreted as the conversion rate among all spinal anesthesia procedures. When related to the 4,012 spinal anesthetics performed during the study period, conversion to general anesthesia after spinal failure represented approximately 1.4% of all spinal anesthesia procedures. This rate is higher than the total failure rate reported by Sng et al. for elective cesarean section but remains within the range of institutional and mixed-population experiences, where conversion may depend on surgery type, urgency, duration, sensory level, and patient tolerance [9].

Postoperative complications were absent in 61 (53.0%) cases, but persistent low back pain, post-dural puncture headache, urinary retention, and transient neurological symptoms were reported in a proportion of patients. These events may be related to repeated puncture attempts, patient factors, surgery type, or perioperative management rather than spinal anesthesia failure alone. Nevertheless, they underline the importance of post-event follow-up. Fettes et al. recommended full documentation, explanation to the patient, and further investigation when clinically indicated after failed spinal anesthesia [10].

Our study has several strengths. It provides original Moroccan data from a high-volume tertiary military teaching hospital, uses a prospective one-year reporting period, and describes not only the reporting-based failure proportion but also failure type, intraoperative management, complications, surgical delay, ICU admission, and satisfaction. It therefore gives a practical and quality-oriented view of recognized spinal anesthesia failure in routine practice.

Several limitations should be acknowledged. First, failed cases were reported voluntarily by anesthesia providers through an electronic form rather than identified through systematic surveillance, independent observation, or complete review of all anesthesia charts. This creates a major risk of selection bias and underreporting, especially for minor or borderline failures. Second, individual-level data were collected only for failed spinal anesthesia cases. Therefore, comparisons with successful spinal anesthesia cases were not possible, and independent predictors of failure could not be established. Third, the denominator was obtained from institutional operating room activity records and allowed only calculation of a

reporting-based proportion. Fourth, the broad umbrella definition of failed spinal anesthesia may have grouped clinically different situations, such as total absence of block, partial block, intraoperative pain requiring minimal supplementation, and conversion to general anesthesia. To limit this problem, failure subtypes were reported separately, but classification uncertainty remained in six cases requiring clinical recoding. Fifth, some important technical variables were not collected, including free CSF flow, CSF appearance, exact dose of local anesthetic, injected volume, sensory testing method, and time from injection to incision. Sixth, no multivariable analysis was performed because the study lacked a successful spinal anesthesia comparison group and was not designed to model predictors. Finally, this was a single-center study, which may limit generalizability to other Moroccan hospitals.

Despite these limitations, the study identifies several practical opportunities for quality improvement: systematic assessment of sensory block before incision, documentation of CSF flow and appearance, recording of exact intrathecal dose, early call for senior assistance after multiple attempts, standardized management algorithms for inadequate block, and structured postoperative follow-up of patients who experience intraoperative pain or conversion to general anesthesia. Future studies should prospectively collect data for both successful and failed spinal anesthesia procedures to allow valid risk-factor analysis and adjustment for confounding.

CONCLUSIONS

In this one-year prospective descriptive study, 120 failed spinal anesthesia cases were reported among 4,012 spinal anesthesia procedures, corresponding to a reporting-based proportion of 3.0%, with 115 cases available for complete analysis. Partial failure was more frequent than total failure, and reported failures were commonly associated with intraoperative pain, intravenous analgesic supplementation, surgical delay, and conversion to general anesthesia. Because case identification relied on voluntary reporting and successful spinal anesthesia procedures were not characterized at the individual level, the study should be interpreted as a descriptive quality-improvement evaluation rather than a definitive incidence or predictor study. Future work should use systematic surveillance of all spinal anesthesia procedures and collect comparable data from successful cases.

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Conflicts of Interest

The authors declare that they have no conflicts of interest.

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Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

REFERENCES

1. Di Cianni S, Rossi M, Casati A, Cocco C, Fanelli G. Spinal anesthesia: an evergreen technique. Acta Biomed. 2008;79(1):9-17.

2. Balavenkatasubramanian TL, Senthilkumar R, Kumar V. Current indications for spinal anesthesia: a narrative review. Best Pract Res Clin Anaesthesiol. 2023;37(2):89-99. doi:10.1016/j.bpa.2023.04.001.
https://doi.org/10.1016/j.bpa.2023.04.001

3. Yüksek A, Miniksar ÖH, Honca M, Öz H. Incidence and causes of failed spinal anaesthesia. Dubai Med J. 2020;3:50-54. doi:10.1159/000508837.
https://doi.org/10.1159/000508837

4. Demilie AE, Denu ZA, Bizuneh YB, Gebremedhn EG. Incidence and factors associated with failed spinal anaesthesia among patients undergoing surgery: a multicenter prospective observational study. BMC Anesthesiol. 2024;24:129. doi:10.1186/s12871-024-02484-y.
https://doi.org/10.1186/s12871-024-02484-y

5. Basques BA, Toy JO, Bohl DD, Golinvaux NS, Grauer JN. General compared with spinal anesthesia for total hip arthroplasty. J Bone Joint Surg Am. 2015;97(6):455-461. doi:10.2106/JBJS.N.00662.
https://doi.org/10.2106/JBJS.N.00662

6. Heckmann ND, De A, Porter KR, Stambough JB. Spinal versus general anesthesia in total knee arthroplasty: are there differences in complication and readmission rates? J Arthroplasty. 2023;38(4):673-679.e1. doi:10.1016/j.arth.2022.10.036.
https://doi.org/10.1016/j.arth.2022.10.036

7. Wilson JM, Farley KX, Bradbury TL, Guild GN. Is spinal anesthesia safer than general anesthesia for patients undergoing revision total hip arthroplasty? Analysis of the ACS-NSQIP Database. Clin Orthop Relat Res. 2020;478(1):80-87. doi:10.1097/CORR.0000000000000887.
https://doi.org/10.1097/CORR.0000000000000887

8. Darwish OM, Lutnick E, Dalimov Z, et al. Neuraxial vs general anesthesia: 30-day mortality outcomes following transurethral resection of prostate. Urology. 2021;157:274-279. doi:10.1016/j.urology.2021.06.034.
https://doi.org/10.1016/j.urology.2021.06.034

9. Sng BL, Lim Y, Sia ATH. An observational prospective cohort study of incidence and characteristics of failed spinal anaesthesia for caesarean section. Int J Obstet Anesth. 2009;18(3):237-241. doi:10.1016/j.ijoa.2009.01.010.
https://doi.org/10.1016/j.ijoa.2009.01.010

10. Fettes PDW, Jansson JR, Wildsmith JAW. Failed spinal anaesthesia: mechanisms, management, and prevention. Br J Anaesth. 2009;102(6):739-748. doi:10.1093/bja/aep096.
https://doi.org/10.1093/bja/aep096

11. Girard T, Savoldelli G. Failed spinal anesthesia for cesarean delivery: prevention, identification and management. Curr Opin Anaesthesiol. 2024;37(3):207-212. doi:10.1097/ACO.0000000000001362.
https://doi.org/10.1097/ACO.0000000000001362

12. Ashagrie HE, Ahmed SA, Melesse DY. The incidence and factors associated with failed spinal anesthesia among parturients who underwent cesarean section: a prospective observational study. Int J Surg Open. 2020;24:47-51. doi:10.1016/j.ijso.2020.03.009.
https://doi.org/10.1016/j.ijso.2020.03.009

13. de Oliveira Filho GR, Gomes HP, da Fonseca MHZ, Hoffman JC, Pederneiras SG, Garcia JHS. Predictors of successful neuraxial block: a prospective study. Eur J Anaesthesiol. 2002;19(6):447-451. doi:10.1017/S0265021502000716.
https://doi.org/10.1017/S0265021502000716

14. Fuzier R, Bataille B, Fuzier V, et al. Spinal anesthesia failure after local anesthetic injection into cerebrospinal fluid: a multicenter prospective analysis of its incidence and related risk factors in 1214 patients. Reg Anesth Pain Med. 2011;36(4):322-326. doi:10.1097/AAP.0b013e318217a68e.
https://doi.org/10.1097/AAP.0b013e318217a68e

15. Lang SA, Prusinkiewicz C, Tsui BCH. Failed spinal anesthesia after a psoas compartment block. Can J Anaesth. 2005;52:74-78. doi:10.1007/BF03018584.
https://doi.org/10.1007/BF03018584

16. Szypula K, Ashpole KJ, Bogod D, et al. Litigation related to regional anaesthesia: an analysis of claims against the NHS in England 1995-2007. Anaesthesia. 2010;65(5):443-452. doi:10.1111/j.1365-2044.2010.06248.x.
https://doi.org/10.1111/j.1365-2044.2010.06248.x

17. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP, et al. The Strengthening the Reporting of Observational Studies in Epidemiology, STROBE, statement: guidelines for reporting observational studies. PLoS Med. 2007;4(10):e296. doi:10.1371/journal.pmed.0040296.
https://doi.org/10.1371/journal.pmed.0040296

18. American Society of Anesthesiologists. ASA Physical Status Classification System. American Society of Anesthesiologists; 2020.

19. Likert R. A technique for the measurement of attitudes. Arch Psychol. 1932;22(140):1-55.

20. Bagle A, Khatri S, Jain R. Failed Spinal Anesthesia: Incidence and Associated Factors. Cureus. 2024;16(12):e76078. doi:10.7759/cureus.76078.
https://doi.org/10.7759/cureus.76078

21. Zegeye ST, Admassie BM, Aligaz EM, Dires FT, Bayable SD. Incidence and predictors of failed spinal anesthesia: a systematic review and meta-analysis. Patient Saf Surg. 2026;20:1. doi:10.1186/s13037-025-00457-9.
https://doi.org/10.1186/s13037-025-00457-9