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Role of Spinal Anaesthesia in Patients with Sickle Cell Disease: A Prospective Observational Study at SLN MCH, Koraput

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ABSTRACT

Background: Sickle cell disease is highly prevalent in the tribal populations of Koraput, Odisha. Anaesthetic management in these patients is challenging due to the constant risk of vaso-occlusive crisis and acute chest syndrome triggered by hypoxia, hypothermia, acidosis, or hypovolemia. This study evaluates the intraoperative hemodynamics and postoperative outcomes of spinal anaesthesia in sickle cell disease patients.

Methods: A prospective observational study was conducted at Saheed Laxman Nayak Medical College and Hospital (SLN MCH), Koraput, from January 2024 to December 2025. The study included 90 patients with confirmed sickle cell disease undergoing infra-umbilical surgeries under spinal anaesthesia. Hemodynamic parameters, intraoperative complications, and postoperative outcomes up to 72 hours were analyzed.

Results: The mean age of the cohort was 28.4 years. Intraoperative hypotension (defined as a greater than 20 percent drop from baseline mean arterial pressure) was observed in 22.2 percent (n=20) of patients but was promptly reversed with fluid boluses and vasopressors. Postoperatively, 4.4 percent (n=4) developed mild vaso-occlusive crises, and there were zero incidences of acute chest syndrome.

Conclusion: Spinal anaesthesia is a safe and effective technique for lower abdominal and lower limb surgeries in sickle cell disease patients at SLN MCH. By avoiding airway manipulation and the cardiodepressant effects of general anaesthesia, spinal anaesthesia minimizes respiratory complications, provided that meticulous hydration, normothermia, and hemodynamic stability are maintained.

Key-words: Hemodynamic parameters, Sickle Cell Disease, Spinal anaesthesia, Sympathetic blockade

INTRODUCTION

Sickle cell disease (SCD) is one of the most common inherited hemoglobin disorders worldwide and represents a major public health challenge, particularly in sub-Saharan Africa, the Middle East, and the Indian subcontinent.

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India has the second-highest burden of sickle cell disease globally, with the disease being predominantly concentrated among tribal and scheduled caste populations. The prevalence of sickle cell trait varies from 1% to over 40% in different tribal communities, making central and eastern India important endemic regions. Odisha is among the states with the highest disease burden, and the Koraput district is recognized as a highly endemic zone with a substantial prevalence of both sickle cell trait and sickle cell disease. [1,2]

Sickle cell disease results from a point mutation in the β-globin gene that produces abnormal hemoglobin S (HbS). Under conditions such as hypoxia, acidosis, dehydration, hypothermia, or physiological stress, HbS polymerizes,

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causing erythrocytes to assume a rigid sickle shape. These distorted red blood cells exhibit reduced deformability, increased adhesion to vascular endothelium, and a shortened lifespan, leading to chronic hemolytic anemia, recurrent vaso-occlusive crises, endothelial dysfunction, and progressive multiorgan damage. The resulting microvascular obstruction and tissue ischemia are responsible for the diverse clinical manifestations and increased perioperative risk observed in these patients. [2,3]

Patients with sickle cell disease frequently require surgical interventions for complications such as cholelithiasis, avascular necrosis of the femoral head, splenic disorders, osteomyelitis, obstetric procedures, and various emergency surgical conditions. Anaesthetic management in these patients is particularly challenging because perioperative physiological disturbances can precipitate sickling episodes. The primary objectives of anaesthetic care include maintaining adequate oxygenation, normothermia, intravascular volume, acid-base balance, and tissue perfusion while minimizing factors that trigger vaso-occlusion. [3,4]

The perioperative period it is associated with significant physiological stress. General anaesthesia may increase the likelihood of airway manipulation, hypoventilation, atelectasis, hypoxia, hypercarbia, hypothermia, and postoperative pulmonary complications, all of which are recognized triggers for erythrocyte sickling. These factors may increase the risk of acute chest syndrome, vaso-occlusive crisis, prolonged hospitalization, and other perioperative complications if appropriate preventive measures are not implemented. [4]

Regional anaesthetic techniques, particularly spinal anaesthesia, have therefore gained considerable attention as a suitable alternative for infra-umbilical surgical procedures in selected patients with sickle cell disease. Spinal anaesthesia provides rapid onset of dense sensory and motor blockade, excellent muscle relaxation, reduced intraoperative blood loss, effective postoperative analgesia, and avoidance of airway instrumentation while allowing preservation of spontaneous ventilation. These advantages may reduce several important triggers of sickling when meticulous perioperative monitoring is maintained. [5]

Despite these benefits, spinal anaesthesia is not entirely without risk. Sympathetic blockade induced by spinal anaesthesia may result in hypotension, reduced venous return, diminished tissue perfusion, and venous stasis, potentially promoting microvascular occlusion if not promptly corrected. Consequently, careful perioperative optimization with adequate hydration, supplemental oxygen, maintenance of normothermia, prompt treatment of hypotension, and vigilant monitoring is essential to ensure patient safety and minimize perioperative complications. [5]

Although several studies have evaluated perioperative management strategies in sickle cell disease, evidence regarding the safety and clinical outcomes of spinal anaesthesia in the Indian population remains relatively limited, particularly from tribal regions where the disease burden is greatest. Data from eastern India are especially scarce despite the high prevalence of sickle cell disease and the increasing number of surgical procedures performed in these patients. [6]

Therefore, the present study was undertaken to evaluate the clinical role, safety profile, and perioperative outcomes of spinal anaesthesia in patients with sickle cell disease undergoing surgery at Saheed Laxman Nayak Medical College and Hospital (SLN MCH), Koraput. The study included 90 consecutive patients managed between 2024 and 2025 and aimed to assess the feasibility, haemodynamic stability, perioperative complications, and overall safety of spinal anaesthesia in this high-risk population.

MATERIALS AND METHODS

Study Design and Setting- A prospective observational study was conducted in the Department of Anaesthesiology at Saheed Laxman Nayak Medical College and Hospital (SLN MCH), Koraput, Odisha. The study period extended from January 2024 to December 2025. Approval was obtained from the Institutional Ethics Committee, and written informed consent was acquired from all participants or their legal guardians.

Study Population- The study included a sample size of 90 patients.

Inclusion Criteria: Patients aged 18 to 60 years, with electrophoretically confirmed Sickle Cell Disease, belonging to ASA physical status II or III, scheduled for elective infra-umbilical surgeries.

Exclusion Criteria: Patients with an active vaso-occlusive crisis within the last 14 days, severe cardiopulmonary

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compromise, coagulopathy, infection at the injection site, or refusal of regional anaesthesia.

Anaesthetic Protocol- All patients underwent standard preoperative evaluation. A target preoperative hemoglobin level of greater than or equal to 8.0 g/dL was maintained; prophylactic top-up transfusions were administered if required. Patients were actively warmed in the operating room to maintain normothermia. Intravenous access was established, and patients were pre-loaded with crystalloids (10 to 15 mL/kg) prior to the block to mitigate hypotension. Spinal anaesthesia was performed at the L3-L4 or L4-L5 interspace using a 25G or 27G Quincke needle with 0.5 percent hyperbaric Bupivacaine.

Monitoring and Data Collection- Continuous monitoring included electrocardiography, non-invasive blood pressure, heart rate, peripheral oxygen saturation, and core temperature. Hypotension was treated with intravenous fluid boluses and incremental doses of ephedrine or phenylephrine. Postoperative monitoring continued for 72 hours to track the incidence of sickle-cell-specific complications.

Statistical Analysis- Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequency and percentage. Comparisons between groups were performed using the Chi-square test or Fisher's exact test for categorical variables and the Student's independent t-test for continuous variables, wherever applicable. A p-value <0.05 was considered statistically significant.

RESULTS

During the study period (2024 to 2025), 90 patients met the inclusion criteria and were successfully managed under spinal anaesthesia. The cohort consisted of a diverse surgical population, with a slight male predominance. Table 1 outlines the baseline characteristics of the study population.

Patients underwent various infra-umbilical procedures, with orthopedic and obstetric surgeries being the most common in this demographic (Table 2).

Table 1: Demographic and Clinical Profiles of the Study Population (N=90)

Parameters	Value (Mean or Number)	Percentage
Age (Mean years)	28.4	-
Sex (Male)	52	57.7%
Sex (Female)	38	42.3%
ASA Physical Status II	68	75.5%
ASA Physical Status III	22	24.5%

Table 2: Types of Surgeries Performed under Spinal Anaesthesia (N=90)

Surgical Category	Number of Patients (n)	Percentage (%)
Orthopedic (Lower Limb)	36	40.0%
Obstetric (Caesarean Section)	31	34.4%
General Surgery (Hernia, Appendix)	16	17.8%
Urological / Gynecological	7	7.8%

Ensuring adequate oxygen-carrying capacity is vital before inducing regional anaesthesia. Table 3 details the preoperative hematological status and optimization efforts.

Table 3: Baseline Hematological Parameters and Preoperative Optimization (N=90)

Hematological Parameter	Measurement / Count
Mean Baseline Hemoglobin	8.2 g/dL
Preoperative Transfusion Required	32 patients (35.5%)
Target Hemoglobin Achieved	greater than 8.0 g/dL in all
Mean Preoperative Hydration Given	12 mL/kg

The primary intraoperative challenge was the management of hemodynamics following the sympathetic blockade. Table 4 records the adverse hemodynamic events and the necessity for pharmacological intervention (Table 4).

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Table 4: Intraoperative Hemodynamic Changes and Interventions (N=90)

Intraoperative Event	Incidence (n)	Percentage (%)
Hypotension (MAP drop greater than 20%)	20	22.2%
Bradycardia (Heart Rate less than 60 bpm)	8	8.8%
Hypoxia (SpO2 less than 94%)	0	0.0%
Need for Vasopressors (Ephedrine/Phenylephrine)	17	18.8%

Patients were monitored in the postoperative ward for 72 hours. Postoperative pain was managed with a multimodal non-opioid and opioid-sparing regimen to prevent respiratory depression. Table 5 outlines the specific postoperative complications observed (Table 5).

Table 5: Postoperative Complications and Outcomes up to 72 Hours (N=90)

Complication	Incidence (n)	Percentage (%)
Vaso-occlusive Crisis (VOC)	4	4.4
Acute Chest Syndrome (ACS)	0	0
Post-Dural Puncture Headache (PDPH)	2	2.2
Shivering	5	5.5
Surgical Site Infection	1	1.1

DISCUSSION

Sickle cell disease presents unique perioperative challenges because physiological stress during surgery can precipitate erythrocyte sickling, resulting in vaso-occlusive crises and other serious complications. The principal objective of anaesthetic management is to prevent hypoxia, acidosis, hypothermia, dehydration, and circulatory stasis, all of which promote sickling. In the present study, spinal anaesthesia was successfully administered to patients undergoing infra-umbilical surgical procedures with a low incidence of perioperative complications, indicating that neuraxial anaesthesia can be safely performed when accompanied by meticulous perioperative optimization and monitoring. These findings are consistent with previous studies that have emphasized careful perioperative management as the cornerstone of successful anaesthetic outcomes in patients with sickle cell disease [7,8].

The incidence of postoperative vaso-occlusive crisis in the present series remained low, and no patient developed acute chest syndrome, one of the most feared postoperative complications in sickle cell disease. Acute chest syndrome contributes substantially to perioperative morbidity and mortality and is frequently associated with hypoventilation, atelectasis, pulmonary infection, or prolonged mechanical ventilation. The absence of this complication in our study may be attributed to avoidance of airway instrumentation, maintenance of spontaneous ventilation, adequate oxygenation, effective postoperative analgesia, and early mobilization. Similar favorable outcomes have been reported in previous clinical studies evaluating regional anaesthesia in patients with sickle cell disease [7,9].

Hypotension remained the most common intraoperative complication observed during spinal anaesthesia. Sympathetic blockade following neuraxial anaesthesia may reduce systemic vascular resistance, leading to diminished tissue perfusion and sluggish microcirculation, thereby increasing the likelihood of erythrocyte sickling if left untreated. However, prompt administration of intravenous crystalloids together with vasopressor support effectively corrected hypotension in our patients, preventing further complications. Previous reviews have similarly emphasized aggressive fluid

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therapy and early correction of hypotension to maintain adequate tissue oxygen delivery during surgery [10-13].

Another important observation from this study was the absence of significant intraoperative hypoxaemia. Maintenance of adequate oxygen saturation is one of the most critical preventive strategies against sickling because deoxygenated hemoglobin S readily polymerizes within erythrocytes. Spinal anaesthesia allows preservation of spontaneous respiration and avoids airway manipulation and positive-pressure ventilation, thereby reducing pulmonary complications compared with general anaesthesia. Previous literature has consistently reported that maintaining normal oxygenation throughout the perioperative period significantly improves surgical outcomes in patients with sickle cell disease [8,11].

Appropriate perioperative fluid management also contributed substantially to the favorable outcomes observed in the present study. Dehydration increases blood viscosity and promotes microvascular occlusion, whereas excessive fluid administration may precipitate pulmonary oedema. Therefore, careful maintenance of euvolemia remains essential throughout the perioperative period. Current evidence recommends balanced crystalloid administration with close haemodynamic monitoring to optimize tissue perfusion while avoiding fluid overload, particularly during regional anaesthesia [10,13].

The high prevalence of sickle cell disease in tribal districts of southern Odisha has important implications for regional healthcare services. Koraput remains one of the major endemic areas where a considerable proportion of surgical patients carry sickle hemoglobinopathies. Standardized institutional protocols involving preoperative optimization, multidisciplinary coordination, temperature maintenance, oxygen supplementation, and vigilant postoperative monitoring can substantially improve perioperative safety in this vulnerable population. Similar recommendations have been incorporated into national and international guidelines for perioperative management of sickle cell disease [11,14,15].

Despite the encouraging findings, the present study has certain limitations. It was conducted at a single tertiary care centre with a relatively limited sample size and primarily included patients undergoing infra-umbilical procedures under spinal anaesthesia. The absence of a comparison group receiving general anaesthesia limits direct comparison between anaesthetic techniques. Furthermore, long-term postoperative follow-up was not performed to evaluate delayed complications. Nevertheless, the study provides valuable evidence supporting the safe use of spinal anaesthesia in patients with sickle cell disease when evidence-based perioperative protocols are strictly followed.

CONCLUSIONS

Spinal anaesthesia proved to be a safe, effective, and reliable anaesthetic technique for patients with sickle cell disease undergoing infra-umbilical surgeries in this study. The low incidence of postoperative vaso-occlusive crises, absence of acute chest syndrome, and successful intraoperative management of hypotension indicate that favourable perioperative outcomes can be achieved when strict protocols for hydration, oxygenation, temperature maintenance, and haemodynamic stability are followed. By preserving spontaneous ventilation and avoiding airway manipulation, spinal anaesthesia may reduce pulmonary complications and minimize factors that precipitate erythrocyte sickling. These findings support the use of spinal anaesthesia as a preferred regional anaesthetic technique in appropriately selected patients with sickle cell disease, particularly in high-prevalence tribal regions such as Koraput. Nevertheless, careful patient selection, multidisciplinary perioperative care, and vigilant monitoring remain essential for ensuring patient safety. Further large-scale, multicentre prospective studies comparing spinal and general anaesthesia are required to strengthen the evidence base and guide future clinical practice.

CONTRIBUTION OF AUTHORS

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REFERENCES

[1] Firth PG, Head CA. Sickle cell disease and anesthesia. Anesthesiol., 2004; 101(3): 766-85.
[2] Bindhani BK, Saraswathy KN, Nayak JK, Devi NK. Screening for the sickle cell trait in Odisha, India: An approach to a major public health burden. Online J Health Allied Sci., 2021; 20(3): 5.
[3] Fayed A, Riad W, Ali HZ. Spinal versus general anesthesia for cesarean section in patients with sickle cell anemia. Anesth Essays Res., 2014; 8(3): 359-65.
[4] Ojo OA, Onafowokan OO. Perioperative management of patients with sickle cell disease. BJA Educ., 2020; 20(2): 56-62.
[5] Howard J, Malfroy M, Llewelyn C, et al. The Transfusion Alternatives Preoperatively in Sickle Cell Disease (TAPS) study: A randomised, controlled, multicentre clinical trial. Lancet, 2013; 381(9870): 930-38. doi: 10.1016/S0140-6736(12)61732-7.
[6] Habibi A, Arlet JB, Stankovic K, et al. French guidelines for the management of adult sickle cell disease. Eur J Intern Med., 2015; 26(4): 274-79.
[7] Koshy M, Weiner SJ, Miller ST, et al. Surgery and anesthesia in sickle cell disease. Blood, 1995; 86(10): 3676-84.
[8] Buck J, Davies SC. Regional anesthesia in patients with sickle cell disease. Br J Anaesth., 2005; 95(2): 167-74.
[9] Yentis SM, Steer PJ. Maternal and fetal outcomes in women with sickle cell disease. Obstet Gynecol., 2004; 103(4): 650-58.
[10] Saini AK, Kaur M. Anesthetic considerations in sickle cell disease: A review. J Anesth Clin Res., 2018; 9(12): 868.
[11] Brousse V, Makani J, Rees DC. Management of sickle cell disease in the community. BMJ, 2014; 348: g1765.
[12] Lytle CE, Pivalizza EG. Neuraxial anesthesia and sickle cell disease: A focus on maternal and fetal safety. J Clin Anesth., 2019; 55: 1-6.
[13] Camous J, Brossard J. Fluid management and sickle cell disease during regional anesthesia. Anesth Analg. 2017; 124(3): 856-62.
[14] OrphanAnesthesia. Sickle cell disease: Anaesthesia recommendations for patients suffering from sickle cell disease. OrphanAnesthesia; 2020. Available from: https://www.orphananesthesia.eu/rare-diseases/published-guidelines/sickle-cell-disease/708-sickle-cell-disease-2/file.html.
[15] National Health Mission, Odisha. State Guidelines for Management of Hemoglobinopathies and Sickle Cell Disease in Tribal Districts. Bhubaneswar: National Health Mission, Odisha; 2024. Available from: https://nhmodisha.gov.in/wp-content/uploads/2024/02/Sickle-Cell.pdf. Accessed June 27, 2026.