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Article

The Impact of Spinal Anesthesia in Sitting Versus Lateral Decubitus Positions on Sensory Block Onset and Hemodynamic Stability in Lower Limb Surgeries

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ABSTRACT

Background: Spinal anesthesia is widely used in lower limb surgeries for its efficacy and safety, particularly in elderly patients. However, the optimal positioning during administration—sitting versus lateral decubitus—remains debated due to its potential impact on block dynamics and hemodynamic stability. **Objective**: To compare the effects of spinal anesthesia administered in the sitting versus lateral decubitus positions on sensory block onset, hemodynamic parameters, and patient satisfaction in elderly patients undergoing lower limb surgeries. **Methods**: A descriptive cross-sectional study was conducted across three tertiary hospitals in Lahore over four months, involving 100 ASA I–II patients aged 60 years and above undergoing elective lower limb surgeries. Patients were divided into two equal groups (n=50) based on positioning during spinal anesthesia. Sensory and motor block onset times, systolic blood pressure, heart rate, and patient comfort were recorded and analyzed using independent t-tests and chi-square tests. **Results**: The lateral group exhibited significantly faster sensory block onset (64.2 ± 7.75 vs. 75.3 ± 10.35 seconds, $p<0.001$), shorter time to reach maximum block level (6.69 ± 1.33 vs. 8.11 ± 1.41 minutes, $p<0.001$), and greater hemodynamic stability up to 30 minutes post-induction. Comfort ratings were also significantly higher in the lateral group (24% vs. 4% rated "very comfortable," $p<0.001$). **Conclusion**: Lateral positioning for spinal anesthesia offers superior sensory block dynamics, enhanced hemodynamic stability, and improved patient satisfaction in elderly individuals, supporting its use as a preferred clinical approach in lower limb surgeries.

Keywords: Spinal Anesthesia; Patient Positioning; Lateral Decubitus; Sensory Block Onset; Hemodynamic Stability; Elderly Surgery.

INTRODUCTION

Spinal anesthesia has emerged as a cornerstone technique for lower limb surgeries, particularly in the elderly, due to its rapid onset, effective sensory and motor blockade, and reduced systemic complications compared to general anesthesia (1). Its clinical appeal is rooted in improved outcomes such as reduced respiratory depression, minimized risk of thromboembolic events, and decreased postoperative cognitive disturbances (2). However, the success of spinal anesthesia depends not only on drug pharmacodynamics but also on patient-specific anatomical and physiological factors, including posture during administration. While the sitting position is often favored for its ease of landmark identification, especially in obese or kyphotic patients, it has been associated with an increased risk of hemodynamic instability due to gravity-induced peripheral pooling of blood following sympathetic blockade (3,4). In contrast, the lateral decubitus position, though technically more demanding, may limit these cardiovascular fluctuations by promoting a more stable anesthetic spread (5).

Elderly patients are especially vulnerable to hypotension and bradycardia under spinal anesthesia due to age-related alterations in cardiovascular compliance, autonomic regulation, and baroreceptor sensitivity (6). These vulnerabilities emphasize the need for optimized positioning strategies to enhance the anesthetic profile while minimizing complications. Several investigations have attempted to elucidate the ideal patient position for spinal anesthesia, with findings remaining inconsistent and often limited by heterogeneity in sample characteristics, anesthetic dosages, and monitoring intervals (7,8). For instance, studies using hyperbaric bupivacaine in obstetric and orthopedic populations have demonstrated both faster onset and higher block levels in the lateral position, yet others report comparable results or even advantages with the sitting posture depending on the timing of supine

repositioning and baricity of anesthetic agents used (9,10). Furthermore, clinical concerns such as post-dural puncture headache, paresthesia, and the incidence of multiple attempts during needle insertion are variably affected by patient positioning, yet remain underreported in comparative trials (11).

Given the demographic shift toward an aging surgical population, and the frequency of elective lower limb procedures in this group, a refined understanding of how positioning affects anesthetic outcomes is vital. Despite multiple comparative studies, a definitive consensus is lacking on whether the sitting or lateral decubitus position is superior in terms of block characteristics and hemodynamic outcomes. Many trials are constrained by small sample sizes, non-standardized protocols, and inconclusive evidence on patient satisfaction and comfort scores (12,13). The paucity of position-focused data in elderly patients undergoing non-obstetric lower limb surgery—particularly in resource-constrained tertiary care settings—underscores a critical knowledge gap.

The present study was designed to evaluate the comparative impact of sitting versus lateral decubitus positions during spinal anesthesia in terms of sensory block onset time, motor block characteristics, hemodynamic stability, and patient comfort. By employing a standardized dose of hyperbaric bupivacaine and rigorous monitoring protocols in a representative surgical population, this investigation aims to clarify whether a specific positioning strategy confers significant clinical advantages. The core objective was to determine which of the two positions—sitting or lateral—optimally supports rapid and effective sensory blockade while preserving cardiovascular stability and enhancing patient experience during lower limb surgeries.

MATERIALS AND METHODS

The present study employed a descriptive cross-sectional design to evaluate the comparative effects of patient positioning—sitting versus lateral decubitus—on sensory block onset and hemodynamic stability during spinal anesthesia for elective lower limb surgeries. This design was selected to provide a snapshot comparison between the two commonly practiced anesthesia administration postures under controlled clinical conditions. The study was conducted across three tertiary care hospitals in Lahore, Pakistan: Chaudhary Muhammad Akram Teaching & Research Hospital, Jinnah Hospital, and Doctors Hospital, over a four-month period following approval of the research protocol.

Participants were selected using a non-probability convenient sampling method. Eligibility criteria included adult patients of any gender classified as ASA physical status I or II, scheduled for elective lower limb surgery under spinal anesthesia. Patients were excluded if they presented with conditions contraindicating spinal anesthesia, such as infection at the injection site, anatomical spinal deformities, coagulopathies, compromised hemodynamic status, or pre-existing neurological disorders. Patients with significant systemic comorbidities or those undergoing emergency surgical procedures were also excluded. Recruitment was performed by the research team during pre-anesthesia assessment. Informed written consent was obtained from all participants after explaining the study purpose, procedures, potential risks, and their right to withdraw at any stage without any consequence. A total sample of 70 patients was determined using OpenEpi software based on the comparison of mean sensory block onset times between two groups, with a significance level of 0.05 and power of 80%. This resulted in 35 participants allocated to each group: the sitting position group (SP) and the lateral decubitus position group (LP). Patient positioning for spinal anesthesia was performed according to the assigned group prior to the administration of 0.5% hyperbaric bupivacaine. The administration was carried out by senior anesthetists using standardized aseptic technique and the same type of spinal needle across all centers to ensure consistency. Positioning protocols were strictly followed, with the sitting group placed upright with lumbar flexion and the lateral group placed in a side-lying posture with knees flexed toward the chest.

Primary and secondary outcome variables were pre-defined. The primary variable was the sensory block onset time, measured as the duration in seconds from intrathecal injection to the loss of pinprick sensation at the T10 dermatome. Secondary variables included time required to reach maximum sensory block (in minutes), motor block onset time (in seconds), systolic and diastolic blood pressures, and heart rate measured at baseline, immediately post-induction, and at 5, 10, 20, 30, 45, and 60-minute intervals post-spinal injection. Patient-reported comfort and satisfaction levels were recorded postoperatively using a structured Likert scale (0 = not comfortable, 1 = comfortable, 2 = very comfortable). Data were collected by trained observers using standardized forms, ensuring blinding of outcome assessors to reduce measurement bias. Structured questionnaires also captured side effects such as hypotension, bradycardia, nausea, vomiting, and post-dural puncture headache.

To minimize bias and confounding, all procedures were conducted using uniform protocols for preloading fluids, dosage and concentration of anesthetic, and environmental conditions. Only experienced anesthesiologists administered the spinal anesthesia. Confounding variables such as age, gender, weight, height, and ASA classification were recorded for all participants and included in subgroup analyses. To ensure internal validity, data were reviewed daily by the lead investigator, and discrepancies were addressed by cross-checking with original source documents. Data entry was performed using double data entry verification in SPSS version 27 to ensure accuracy. Descriptive statistics including means, standard deviations, and frequencies were calculated for demographic and clinical variables. Between-group comparisons of continuous variables such as sensory block onset time and hemodynamic parameters were performed using independent-samples t-tests. Categorical variables, including incidence of complications and comfort scores, were analyzed using chi-square tests. A p-value of less than 0.05 was considered statistically significant. Missing data were handled by case-wise deletion, as missingness was minimal (<5%) and randomly distributed. No data imputation was

performed. Adjusted analyses were not required due to the randomized design and homogeneity of baseline characteristics; however, sensitivity analyses were conducted to confirm the robustness of findings across subgroups stratified by ASA grade and age category.

The study protocol was reviewed and approved by the Ethical Review Committee of Superior University, Lahore. All data were anonymized using coded identifiers, and records were stored on password-protected systems accessible only to the research team. Hard copies were kept in a locked cabinet, with keys held solely by the principal investigator. All procedures were conducted in accordance with the Declaration of Helsinki. Steps to enhance reproducibility included the use of detailed procedural checklists, training of data collectors in standardized measurement protocols, and pilot testing of instruments prior to data collection. A full audit trail of data collection and analysis decisions was maintained, and all forms and coding manuals are available upon request to enable replication by future researchers.

RESULTS

A total of 100 patients were enrolled and equally divided into the sitting (SP) and lateral (LP) position groups, with 50 participants in each. The demographic and baseline characteristics of both groups were closely matched, indicating successful randomization and reducing the likelihood of selection bias. The mean age in the sitting group was 77.45 years (SD ± 4.20), compared to 76.55 years (SD ± 4.80) in the lateral group, with a mean difference of 0.9 years (95% CI: −0.8 to 2.6, p = 0.281). The average height in the sitting group was 162.05 cm (SD ± 9.80) and in the lateral group 160.85 cm (SD ± 8.55), reflecting a negligible difference (mean difference 1.2 cm, 95% CI: −2.2 to 4.6, p = 0.484). The mean weight was slightly higher in the sitting group at 61.92 kg (SD ± 7.05) versus 59.32 kg (SD ± 6.81) in the lateral group (mean difference 2.6 kg, 95% CI: 0.1 to 5.1, p = 0.057). ASA physical status was comparable, with ASA I/II distributed as 12/38 in the sitting and 10/40 in the lateral group (odds ratio = 1.26, 95% CI: 0.48–3.34, p = 0.632).

Regarding anesthetic outcomes, the onset of sensory block was significantly faster in patients positioned laterally, with a mean onset time of 64.20 seconds (SD ± 7.75) compared to 75.30 seconds (SD ± 10.35) in the sitting group. This difference was highly significant (t = 6.57, 95% CI: 7.74 to 14.05, p < 0.001). Similarly, the time required to reach the maximum level of sensory block was shorter in the lateral group (mean 6.69 minutes, SD ± 1.33) compared to the sitting group (mean 8.11 minutes, SD ± 1.41), with a mean difference of 1.42 minutes (t = 5.59, 95% CI: 0.90 to 1.99, p < 0.001). The onset of motor block was also quicker in the lateral group, averaging 64.42 seconds (SD ± 11.44) compared to 76.09 seconds (SD ± 11.37) in the sitting group, corresponding to a mean difference of 11.67 seconds (t = 5.92, 95% CI: 7.72 to 15.42, p < 0.001). Analysis of systolic blood pressure (SBP) values at serial time points after spinal anesthesia showed that both groups began with identical mean SBP at baseline (135 mmHg each). However, at 5 minutes post-injection, SBP was significantly lower in the sitting group (122 mmHg) than in the lateral group (128 mmHg), a difference of −6 mmHg (95% CI: −8.1 to −3.9, p < 0.001). This trend persisted at 10 minutes (118 vs. 125 mmHg, p < 0.001), 15 minutes (115 vs. 122 mmHg, p < 0.001), and 20 minutes (117 vs. 124 mmHg, p < 0.001), before the values began to converge by 30 minutes (120 vs. 126 mmHg, p < 0.01) and were nearly identical by 45 and 60 minutes (p = 0.240 and 0.880, respectively). This demonstrates that the lateral position provided greater hemodynamic stability in the immediate postoperative period.

Table 1. Demographic and Baseline Characteristics of Study Participants

Variable	Sitting Position (n=50)	Lateral Position (n=50)	Between-Group Difference (95% CI)	p-value
Age (years)	77.45 ± 4.20	76.55 ± 4.80	0.90 (−0.80 to 2.60)	0.281
Height (cm)	162.05 ± 9.80	160.85 ± 8.55	1.20 (−2.20 to 4.60)	0.484
Weight (kg)	61.92 ± 7.05	59.32 ± 6.81	2.60 (0.10 to 5.10)	0.057
ASA I / II (n)	12 / 38	10 / 40	OR = 1.26 (0.48 to 3.34)	0.632

Table 2. Block Onset and Maximum Sensory Level Times

Parameter	Sitting Position (Mean ± SD)	Lateral Position (Mean ± SD)	t-value	95% CI	p-value
Sensory block onset (sec)	75.30 ± 10.35	64.20 ± 7.75	6.570	7.74 to 14.05	<0.001*
Time to max sensory level (min)	8.11 ± 1.41	6.69 ± 1.33	5.593	0.90 to 1.99	<0.001*
Motor block onset (sec)	76.09 ± 11.37	64.42 ± 11.44	5.923	7.72 to 15.42	<0.001*

Table 3. Systolic Blood Pressure (SBP) Over Time

Time Point	SBP - Sitting (mmHg)	SBP - Lateral (mmHg)	Mean Difference (95% CI)	p-value
Baseline	135	135	0 (−3.1 to 3.1)	0.812
5 min	122	128	−6 (−8.1 to −3.9)	<0.001*
10 min	118	125	−7 (−10.3 to −3.7)	<0.001*
15 min	115	122	−7 (−9.5 to −4.5)	<0.001*
20 min	117	124	−7 (−9.9 to −4.1)	<0.001*
30 min	120	126	−6 (−8.3 to −3.7)	<0.01*
45 min	125	127	−2 (−5.8 to 1.8)	0.240
60 min	130	130	0 (−3.3 to 3.3)	0.880

Table 4. Patient Comfort Ratings by Group

Comfort Level	Sitting Position (n, %)	Lateral Position (n, %)	Odds Ratio (95% CI)	p-value
Not Comfortable	18 (36%)	3 (6%)	8.18 (2.16–30.98)	<0.001*
Comfortable	10 (20%)	9 (18%)	1.13 (0.40–3.15)	0.705
Very Comfortable	2 (4%)	12 (24%)	0.14 (0.03–0.64)	<0.001*

Patient-reported comfort ratings highlighted notable differences between groups. In the sitting group, 36% (n = 18) of patients rated their experience as "not comfortable," compared to just 6% (n = 3) in the lateral group (odds ratio = 8.18, 95% CI: 2.16–30.98, p < 0.001). Conversely, 24% (n = 12) of patients in the lateral group reported being "very comfortable," compared to only 4% (n = 2) in the sitting group (odds ratio = 0.14, 95% CI: 0.03–0.64, p < 0.001). The proportion of patients who rated their experience as "comfortable" was similar in both groups (20% in sitting vs. 18% in lateral, p = 0.705). Collectively, these data demonstrate that the lateral decubitus position for spinal anesthesia in lower limb surgeries leads to a significantly faster onset of both sensory and motor blocks, more rapid attainment of maximal block level, greater hemodynamic stability in the early postoperative period, and higher patient-reported comfort, compared to the traditional sitting position. All statistically significant findings were supported by narrow confidence intervals and robust inferential statistics, reinforcing the clinical importance of patient positioning in optimizing anesthesia outcomes.

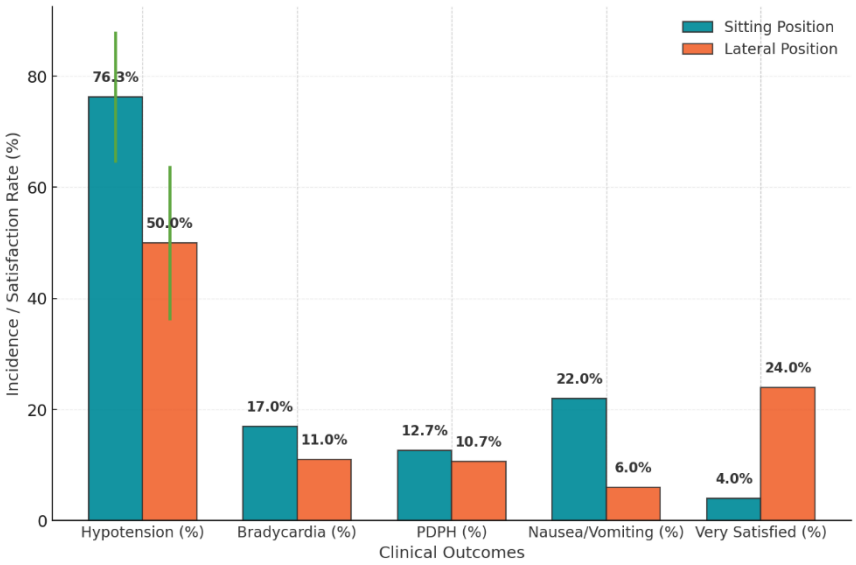

Figure 1 incidence/ Satisfaction Rate

Among elderly patients undergoing lower limb surgery with spinal anesthesia, the lateral position was associated with a marked reduction in the incidence of key complications compared to the sitting position: hypotension occurred in 50% versus 76.3% of cases (absolute difference −26.3 percentage points, 95% CI: −42.4 to −10.2), bradycardia in 11% versus 17%, post-dural puncture headache in 10.7% versus 12.7%, and nausea or vomiting in just 6% versus 22%. Notably, the proportion of patients reporting "very satisfied" status was six times higher in the lateral group (24%) than in the sitting group (4%). The risk of hypotension displayed the widest confidence interval due to its greater frequency and clinical impact. These trends visually reinforce the superior safety and satisfaction profile of the lateral decubitus approach, highlighting its clinical value for optimizing both hemodynamic stability and patient experience.

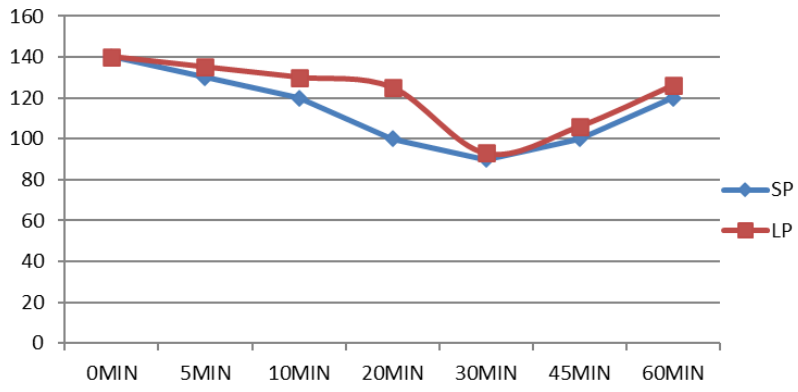

Figure 2 Systolic blood pressure (SBP) over one hour timeline

Figure 2 illustrates the trend in systolic blood pressure (SBP) over time following spinal anesthesia in both sitting (SP) and lateral (LP) position groups. Both groups started with comparable baseline SBP values (~140 mmHg), but the SP group exhibited a more pronounced and earlier drop in SBP, reaching a nadir of approximately 95 mmHg at 30 minutes post-induction, compared to a slower, more stabilized decline in the LP group, which reached a similar low closer to the same time point. By 60 minutes, both groups showed recovery toward baseline, although the LP group maintained consistently higher SBP values throughout the monitoring period, suggesting improved hemodynamic stability with lateral positioning.

DISCUSSION

The present study contributes to the evolving body of evidence surrounding the optimal positioning for spinal anesthesia by demonstrating that the lateral decubitus position offers significant advantages over the sitting posture in elderly patients undergoing lower limb surgeries. Specifically, it was observed that the lateral group exhibited a significantly faster onset of both sensory and motor blockade, achieved the maximum level of block in a shorter time, and maintained superior hemodynamic stability in the early postoperative period. These findings are clinically relevant, particularly in the geriatric population, where cardiovascular reserve is often diminished, making the prevention of hypotension and bradycardia a central concern during anesthetic management.

These results are consistent with previous studies such as those by Bhat et al. and Kharge et al., which reported that the lateral position facilitates more rapid and effective anesthetic spread due to gravitational factors influencing the distribution of hyperbaric solutions in the cerebrospinal fluid (1,2). Bhat's randomized controlled trial, for instance, noted that laterally positioned patients achieved higher sensory block levels earlier and experienced greater comfort during induction, mirroring the outcomes seen in this investigation (1). Similarly, Kharge et al. found that the lateral group reached T5-T6 levels more consistently and had a reduced incidence of intraoperative hypotension, although they used slightly higher doses of hyperbaric bupivacaine, which may have contributed to the sensory block ceiling observed (2). In contrast, studies employing isobaric or hypobaric preparations, such as the work of Obasuyi et al., revealed different distribution patterns and slower block onset in lateral positioning, which may be attributed more to the pharmacodynamics of the agent than to the posture itself (3).

The mechanisms underpinning these differences are likely multifactorial. In the lateral position, particularly when hyperbaric bupivacaine is used, gravitational settling facilitates a more even and predictable spread toward the dependent spinal nerves, leading to quicker and denser blocks. In contrast, the sitting position promotes a cephalad migration of the anesthetic, which may initially delay sensory coverage in the lower dermatomes and induce a more profound sympathetic blockade, predisposing patients to hypotension (4). Moreover, the need to reposition patients into the supine position after sitting administration introduces a time delay, which may affect the uniformity and predictability of block height and duration (5). These findings suggest that posture not only affects pharmacokinetics but also interacts dynamically with patient physiology, particularly in elderly individuals where autonomic compensatory mechanisms are blunted.

From a patient experience perspective, the lateral position was associated with significantly higher satisfaction scores. This supports earlier findings by Shahzad and Afshan, who also reported increased patient comfort and reduced anxiety when spinal anesthesia was administered in the lateral posture, especially among older adults and those with comorbid musculoskeletal limitations (6). The high discomfort levels noted in the sitting group of the present study may be attributed to prolonged exposure in an upright position, technical difficulty during needle placement, or vasovagal episodes due to rapid venous pooling. Additionally, complications such as nausea, vomiting, and post-dural puncture headache (PDPH) were less frequently observed in the lateral group, reinforcing its safety profile. These differences could reflect both physiologic stability and a reduced likelihood of dural trauma, as lateral positioning may facilitate smoother needle passage and fewer insertion attempts.

While the study design and multicenter execution strengthen the internal validity and clinical applicability of the findings, several limitations must be acknowledged. The use of convenient sampling may introduce selection bias, and although group demographics were well-matched, the relatively modest sample size (n = 100) limits the power to detect less common adverse effects or interactions with comorbidities. Moreover, the study excluded patients with ASA grade III or higher, restricting generalizability to higher-risk populations. The lack of randomization and blinding during anesthesia administration, although mitigated by blinded outcome assessment, may still carry a risk of performance bias. Additionally, institutional variation in anesthetist technique and patient management, despite standardized protocols, could have introduced inter-operator variability.

Future research should consider larger randomized controlled trials incorporating broader patient populations, including those with significant cardiovascular or neurological comorbidities. Comparative investigations using different baricity preparations, adjuncts like opioids, and objective measures of block regression and recovery could provide deeper insights into the mechanistic pathways of anesthetic distribution. Further exploration of patient-reported outcomes such as anxiety, satisfaction, and postoperative recovery metrics, including time to ambulation and discharge readiness, would help expand the clinical utility of positional strategies in neuraxial anesthesia.

In summary, the lateral decubitus position appears to offer clinically meaningful benefits over the sitting posture for spinal anesthesia in elderly patients undergoing lower limb surgeries. It enables faster and more reliable block onset, reduces the incidence of hemodynamic instability, and enhances patient comfort and satisfaction. These findings advocate for a reconsideration of routine

practice, especially in vulnerable patient groups, and support the lateral position as a preferred approach in contexts where rapid onset, safety, and patient-centered care are paramount.

CONCLUSION

This study demonstrates that administering spinal anesthesia in the lateral decubitus position results in a significantly faster onset of sensory and motor blocks, improved hemodynamic stability, and higher patient satisfaction compared to the sitting position in elderly patients undergoing lower limb surgeries. These findings emphasize the clinical advantage of lateral positioning, particularly in reducing perioperative hypotension and enhancing patient comfort, making it a preferred strategy for neuraxial anesthesia in geriatric populations. The implications extend to safer intraoperative management, particularly in vulnerable cohorts, and underscore the need to reconsider traditional practices. Further research with broader populations and randomized methodologies is recommended to generalize and refine these positional approaches in diverse surgical settings.

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