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Optimizing Anesthetic Techniques: Special Brachial Plexus and Cutaneous Blocks in Clavicle Fracture Surgeries in Bangladesh

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Abstract **Original Research Article**

***Background*:** This study compares the efficacy, safety, and resource utilization of brachial plexus + cutaneous nerve blocks (RAG) versus conventional anesthesia (CAG) in patients undergoing clavicle fracture surgeries. ***Methods*:** A total of 100 patients were enrolled and equally divided into the RAG (n=50) and CAG (n=50) groups. Baseline characteristics, intraoperative and postoperative outcomes, postoperative complications, length of hospital stay, and resource utilization were evaluated. Pain control was assessed using the Visual Analog Scale (VAS), and patient satisfaction was measured with a satisfaction score. ***Results*:** Baseline characteristics were comparable between the groups. Significant differences were observed in postoperative pain control, with the RAG group demonstrating lower VAS scores at all postoperative intervals ($p < 0.001$). Patient satisfaction was significantly higher in the RAG group (9.5 ± 0.8 vs. 8.3 ± 1.3, $p < 0.001$). Although no significant differences were found in respiratory depression, nausea, or wound infections, the RAG group showed trends toward reduced nausea and prolonged recovery. The RAG group also had a significantly shorter length of hospital stay (2.8 ± 0.7 days vs. 3.4 ± 1.0 days, $p < 0.01$) and reduced supplemental analgesic use (20% vs. 50%, $p < 0.001$). Ultrasonographic guidance was used in 80% of RAG cases. ***Conclusion*:** Brachial plexus and cutaneous nerve blocks provide superior postoperative pain control, greater patient satisfaction, and shorter recovery times compared to conventional anesthesia. These advantages, coupled with reduced reliance on supplemental analgesics, make regional anesthesia a more efficient and cost-effective option for clavicle fracture surgeries. Ultrasonographic guidance may further enhance the application of this technique in clinical practice.

Keywords: Brachial Plexus Block, Conventional Anesthesia, Clavicle Fracture, Surgery Postoperative Pain, Control Patient Satisfaction.

INTRODUCTION

Clavicle fractures are among the most common orthopedic injuries, representing approximately 2.6% of all fractures globally and up to 44% of shoulder girdle injuries [1, 2]. These fractures often require surgical intervention, particularly in displaced or complex cases, to restore function and prevent long-term disability [3]. Effective perioperative pain management is a cornerstone of successful surgical outcomes, facilitating faster recovery, minimizing complications, and improving patient satisfaction [4]. However, traditional approaches relying on general anesthesia and systemic analgesics are associated with significant side effects, such as respiratory depression, nausea, and delayed recovery [5–7], underscoring the need for alternative strategies.

Regional anesthesia techniques, including brachial plexus and cutaneous nerve blocks, have emerged as effective alternatives to general anesthesia for clavicle surgeries [1]. The brachial plexus block, targeting the supraclavicular or interscalene regions, provides targeted analgesia by anesthetizing the C5-T1 nerves that supply the shoulder and upper limb, achieved by inhibiting sodium channels in nerve membranes to block pain transmission [8]. Complementing this, the cutaneous block anesthetizes the supraclavicular nerves (C3-C4), addressing the sensory innervation of the skin over the clavicle [9].

Together, these techniques offer comprehensive pain control, reducing the need for systemic opioids and minimizing side effects such as nausea, respiratory depression, and delayed recovery [10, 11]. By avoiding

general anesthesia, they also lower perioperative risks and facilitate enhanced postoperative recovery, particularly in high-risk patients [12]. This multimodal approach aligns with widely adopted enhanced recovery pathways in orthopedic surgery, ensuring patient comfort and better clinical outcomes [10, 11].

In many developed countries, regional anesthesia has become the standard of care for clavicle surgeries, supported by advancements such as ultrasound-guided techniques and extensive training programs for anesthesiologists [13]. These practices ensure precise delivery of anesthetics, improved efficacy, and minimized risks [13]. Additionally, standardized protocols incorporating regional blocks as part of multimodal analgesia have demonstrated superior outcomes in pain management and recovery [14].

In contrast, developing countries like Bangladesh face significant challenges in adopting these advanced techniques [15, 16]. Resource limitations, including inadequate access to ultrasound machines and high-quality anesthetic agents, combined with inconsistent training opportunities, hinder widespread implementation [17]. At tertiary care facilities such as the National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), high patient loads and infrastructure constraints further complicate the adoption of optimized anesthetic protocols [18].

Despite these challenges, the potential benefits of brachial plexus and cutaneous nerve blocks for clavicle surgeries in Bangladesh are compelling. By providing effective intraoperative and prolonged postoperative pain control, these techniques can enhance patient outcomes and reduce the healthcare burden. However, there is a paucity of data evaluating the feasibility and effectiveness of these methods in the Bangladeshi context, where patient demographics and healthcare infrastructure differ significantly from those in developed settings.

This study aims to bridge this gap by assessing the clinical outcomes, patient satisfaction, and feasibility of incorporating brachial plexus and cutaneous nerve blocks into routine anesthetic protocols for clavicle surgeries at NITOR. By comparing these regional techniques to conventional anesthesia methods, the findings aim to provide evidence-based recommendations for optimizing anesthetic practices in Bangladesh, ultimately contributing to improved surgical outcomes and a more efficient healthcare system.

METHODS AND MATERIALS

Study Design

This is an observational study conducted at the Department of Anesthesiology of the National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Dhaka, Bangladesh between July 2022 and September 2023. The study aims to evaluate the effectiveness of brachial plexus and cutaneous nerve blocks in clavicle fracture surgeries, focusing on pain management, patient satisfaction, and resource utilization. Data were extracted from the hospital's medical records, covering preoperative, intraoperative, and postoperative parameters. This allowed for a real-world evaluation of the multidrug regimen outcomes without altering routine clinical practices.

Study Population

The study included adult patients undergoing clavicle fracture surgeries at the Department of Anesthesiology of the National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR). Eligible participants were identified based on rigorous inclusion and exclusion criteria to ensure the safety and relevance of the study findings.

Inclusion criteria required patients to be aged 18 years or older, classified as American Society of Anesthesiologists (ASA) physical status I–III, and capable of providing written informed consent. These criteria ensured the selection of patients with stable health conditions suitable for regional anesthesia and surgical intervention.

Patients were excluded if they had known allergies or contraindications to local anesthetics, preexisting neurological disorders affecting the brachial plexus or supraclavicular nerves, or coagulation disorders. Additionally, individuals on anticoagulant therapy or those unwilling to provide consent were excluded. These exclusions aimed to mitigate potential risks and confounding variables, maintaining the integrity of the study and the safety of participants.

Patients were categorized into two groups:

1. **Regional Anesthesia Group (RAG):)** and the Patients receiving brachial plexus and cutaneous nerve blocks (Brachial Plexus + Cutaneous Blocks group) for anesthesia.
2. **Conventional Anesthesia Group (CAG):** Patients undergoing surgery with traditional general anesthesia methods.

Sample Size Determination

The sample size for this study was calculated based on the primary outcomes of postoperative pain scores and patient satisfaction to evaluate the effectiveness of regional anesthesia techniques, specifically brachial plexus and cutaneous nerve blocks, compared to conventional methods for clavicle fracture surgeries.

At a 5% significance level and 80% power, the total sample size was estimated to be 100 patients. This sample size ensures robust statistical analysis, improves generalizability, and accommodates variability in patient characteristics. It also accounts for heterogeneity in

surgical practices, patient demographics, and the varying levels of anesthetic expertise at the National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR).

Data Collection and Variables

Data for this study were prospectively collected from patients who underwent clavicle fracture surgeries at the National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR). Eligible patients were identified based on predefined inclusion and exclusion criteria. Baseline demographic information, clinical details, anesthetic techniques used, and postoperative outcomes were documented using a standardized data collection form. All data were gathered under strict ethical guidelines, ensuring confidentiality and patient consent.

Dependent Variables

The primary dependent variables in this study were selected to assess both the effectiveness and safety of the anesthetic techniques.

Postoperative Pain Scores:

Measured using the Visual Analog Scale (VAS) at multiple time points (immediate postoperative period, 6, 12, and 24 hours) to assess pain control.

Patient Satisfaction:

Assessed with a validated satisfaction questionnaire to capture patients' perceptions of pain management and overall comfort during the perioperative period.

Postoperative Complications:

Monitored for respiratory depression, nausea, and prolonged recovery times to evaluate the safety of the anesthetic techniques.

Length of Hospital Stay: Documented in days to assess the impact of the anesthesia method on recovery time and discharge.

Independent Variables

The independent variables encompassed a range of demographic, clinical, and procedural factors that could influence the outcomes of interest:

1. **Demographic Factors**: Age, gender, body mass index (BMI), and socioeconomic status.
2. **Clinical Factors**: Fracture type (e.g., displaced vs. non-displaced), comorbidities (e.g., diabetes, hypertension), and preoperative pain levels.
3. **Anesthetic Techniques**: Type of anesthesia administered (e.g., regional anesthesia with brachial plexus and cutaneous blocks vs. general anesthesia).
4. **Surgical Factors**: Duration of surgery and intraoperative blood loss.
5. **Resource Utilization**: Availability of ultrasonographic guidance, expertise of the anesthesiologist, and use of supplemental analgesics.
6. **Anesthetic Techniques**: The study focuses on two regional anesthesia techniques:

I. Brachial Plexus Block:

A supraclavicular approach will be used to anesthetize the C5-T1 nerves responsible for innervating the shoulder and upper arm. Ultrasound guidance will be employed where available to ensure precise placement of the local anesthetic.

II. Cutaneous Nerve Block:

This technique targets the supraclavicular nerves (C3-C4) to anesthetize the sensory innervation of the skin overlying the clavicle, ensuring comprehensive pain control.

Statistical Analysis

Data will be analyzed using statistical software STATA (version 18). Continuous variables will be expressed as mean ± standard deviation or median (interquartile range), while categorical variables will be presented as frequencies and percentages.

- **Primary Outcomes:** Pain levels (VAS) and patient satisfaction scores.
- **Secondary Outcomes:** Time to first analgesic requirement and incidence of adverse events.

Comparative analyses will use independent t-tests or Mann-Whitney U tests for continuous variables and chi-square or Fisher's exact tests for categorical variables. A p-value <0.05 will indicate statistical significance.

This methodical approach ensures a comprehensive evaluation of the effectiveness and feasibility of regional anesthesia techniques in the Bangladeshi healthcare setting, contributing to improved clinical practices and patient outcomes.

Ethical Considerations

Ethical approval will be obtained from the Institutional Review Board of NITOR. All participants will receive a detailed explanation of the study objectives and procedures before providing written informed consent. Confidentiality of patient data will be strictly maintained, and participants will have the right to withdraw at any stage without any repercussions.

RESULTS

Baseline Characteristics

The study enrolled 100 patients undergoing clavicle fracture surgeries, divided equally between the Brachial Plexus + Cutaneous Blocks group (RAG) and the Conventional Anesthesia group (CAG). Baseline characteristics were comparable across the groups. The mean age of patients was 34.8 ± 13.1 years in the RAG group and 36.0 ± 11.6 years in the CAG group, with no statistically significant difference ($p = 0.52$). Gender distribution was also similar, with males comprising 60%

of the RAG group and 64% of the CAG group (p = 0.68). The mean BMI was 23.9 ± 2.8 in the RAG group and 23.5 ± 3.4 in the CAG group, which was not statistically different (p = 0.44). Fracture classifications were evenly distributed, with displaced fractures observed in 60% of patients in the RAG group and 56% in the CAG group (p = 0.70). ASA classifications were likewise comparable, with similar distributions of ASA I, II, and III statuses between the groups (p > 0.05) (Table 1).

Table 1: Baseline Characteristics of Patients Undergoing Clavicle Fracture Surgeries (n=100)

Variable	RAG (n=50)	CAG (n=50)	p-value
Age (mean ± SD, years)	34.8 ± 13.1	36.0 ± 11.6	0.52
Gender n (%)			
Male	30 (60%)	32 (64%)	0.68
Female	20 (40%)	18 (36%)	0.68
BMI, (mean ± SD)	23.9 ± 2.8	23.5 ± 3.4	0.44
Fracture Classification n (%)			
Displaced	30 (60%)	28 (56%)	0.70
Non-displaced	20 (40%)	22 (44%)	0.70
ASA Classification n (%)			
ASA I	25 (50%)	24 (48%)	0.85
ASA II	20 (40%)	22 (44%)	0.67
ASA III	5 (10%)	4 (8%)	0.72

Intraoperative and Postoperative Outcomes

In terms of intraoperative and postoperative outcomes, shown in, demonstrated significant differences in pain control and patient satisfaction while maintaining comparable safety profiles. The mean duration of surgery was 84.2 ± 10.8 minutes in the RAG group and 86.8 ± 13.9 minutes in the CAG group (p = 0.32), with no significant differences in intraoperative blood loss (145.8 ± 30.6 mL vs. 155.0 ± 38.4 mL, p = 0.15). Postoperative pain scores measured using the Visual Analog Scale (VAS) revealed significantly better pain control in the RAG group. Immediate postoperative VAS scores were markedly lower in the RAG group (2.1 ± 0.6) compared to the CAG group (4.9 ± 0.9), and this trend persisted at 6 hours (2.0 ± 0.7 vs. 4.4 ± 1.0), 12 hours (1.8 ± 0.9 vs. 3.8 ± 1.1), and 24 hours (1.5 ± 0.8 vs. 2.7 ± 0.9) postoperatively, with all comparisons showing p < 0.001 (Table 2).

Patient satisfaction scores further emphasized the advantage of regional anesthesia, with the RAG group reporting significantly higher satisfaction (9.5 ± 0.8) compared to the CAG group (8.3 ± 1.3, p < 0.001). These findings underscore the efficacy of brachial plexus and cutaneous nerve blocks in reducing postoperative pain and enhancing patient comfort, all while maintaining comparable intraoperative metrics and safety profiles (Table 2).

Table 2: Intraoperative and Postoperative Outcomes

Outcome	RAG (n=50)	CAG (n=50)	p-value
Duration of Surgery (minutes)	84.2 ± 10.8	86.8 ± 13.9	0.32
Intraoperative Blood Loss (mL)	145.8 ± 30.6	155.0 ± 38.4	0.15
Postoperative Pain Scores (VAS)			
Immediate Post-op	2.1 ± 0.6	4.9 ± 0.9	**<0.001**
6 hours	2.0 ± 0.7	4.4 ± 1.0	**<0.001**
12 hours	1.8 ± 0.9	3.8 ± 1.1	**<0.001**
24 hours	1.5 ± 0.8	2.7 ± 0.9	**<0.001**
Patient Satisfaction Score	9.5 ± 0.8	8.3 ± 1.3	**<0.001**

Postoperative Complications

Postoperative complications were evaluated to compare the safety profiles of the two anesthetic techniques. Respiratory depression occurred in 6% of patients in the Conventional Anesthesia group (CAG), while no cases were observed in the Brachial Plexus + Cutaneous Blocks group (RAG), although the difference did not reach statistical significance (p = 0.08). Nausea was reported in 10% of patients in the RAG group and 20% in the CAG group, with a p-value of 0.16, indicating no significant difference. Prolonged recovery was observed in 6% of the RAG group and 14% of the CAG group (p = 0.18). Wound infection rates were identical, occurring in 2% of patients in both groups (p = 1.00), highlighting comparable surgical site outcomes regardless of the anesthetic technique employed (Table3).

Table 3: Postoperative Complications

Complication	RAG (n=50)	CAG (n=50)	p-value
Respiratory Depression n (%)	0 (0%)	3 (6%)	0.08
Nausea n (%)	5 (10%)	10 (20%)	0.16
Prolonged Recovery n (%)	3 (6%)	7 (14%)	0.18
Wound Infection n (%)	1 (2%)	1 (2%)	1.00

Length of Hospital Stay and Resource Utilization

Significant differences were observed in resource utilization and recovery metrics (Table 4). The mean length of hospital stay was significantly shorter for the RAG group (2.8 ± 0.7 days) compared to the CAG group (3.4 ± 1.0 days, $p < 0.01$), reflecting faster postoperative recovery in patients receiving regional anesthesia. Additionally, supplemental analgesic use was markedly reduced in the RAG group, with only 20% requiring additional pain relief compared to 50% in the CAG group ($p < 0.001$) (Table3).

Ultrasonographic guidance was utilized in 80% of cases in the RAG group and was not required in the CAG group ($p < 0.001$), reflecting the technical aspects of the regional anesthesia approach. While this represents additional procedural steps in the RAG group, the reduced reliance on systemic analgesics and shorter hospital stays suggest potential offsets in overall resource utilization (Table4).

Table 4: Length of Hospital Stay and Resource Utilization

Parameter	RAG (n=50)	CAG (n=50)	p-value
Length of Hospital Stay (days, mean ± SD)	2.8 ± 0.7	3.4 ± 1.0	**<0.01**
Use of Supplemental Analgesics n (%)	10 (20%)	25 (50%)	**<0.001**
Requirement for Ultrasonographic Guidance n (%)	40 (80%)	0 (0%)	**<0.001**

DISCUSSION

The current study evaluates the clinical outcomes, patient satisfaction, and feasibility of integrating brachial plexus and cutaneous nerve blocks into standard anesthetic protocols for clavicle surgeries. The goal is to offer evidence-based recommendations for enhancing anesthetic practices in Bangladesh.

The study demonstrates a well-balanced randomization, ensuring that baseline characteristics did not significantly differ between the groups. Key metrics such as age ($p = 0.52$), gender distribution ($p = 0.68$), BMI ($p = 0.44$), fracture classification ($p = 0.70$), and ASA status ($p > 0.05$) were statistically comparable, aligning with the requirements for minimizing confounding variables in clinical trials [19]. This comparability allows the outcomes to be attributed primarily to the anesthesia techniques rather than demographic or clinical differences.

The similar duration of surgery (RAG: 84.2 ± 10.8 minutes vs. CAG: 86.8 ± 13.9 minutes, $p = 0.32$) and intraoperative blood loss (RAG: 145.8 ± 30.6 mL vs. CAG: 155.0 ± 38.4 mL, $p = 0.15$) confirm that brachial plexus and cutaneous nerve blocks do not impede surgical efficiency or increase intraoperative risks. This finding aligns with prior evidence indicating that regional anesthesia techniques can provide a stable operative field without influencing hemodynamic or time-related parameters during surgery [20].

Postoperative pain scores, a critical indicator of recovery quality, were markedly lower in the RAG group at all measured intervals ($p < 0.001$). Immediate postoperative VAS scores were more than halved in the RAG group compared to the CAG group, reflecting the superior efficacy of brachial plexus and cutaneous nerve blocks in providing prolonged and effective analgesia. These findings corroborate earlier studies suggesting that regional blocks reduce nociceptive input from the surgical site, resulting in significantly better pain control and reduced opioid consumption post-surgery [21, 22].

The significantly higher patient satisfaction scores in the RAG group (9.5 ± 0.8 vs. 8.3 ± 1.3, $p < 0.001$) underscore the role of effective pain management in enhancing the overall patient experience. Satisfaction in surgical patients is influenced not only by clinical outcomes but also by perioperative comfort and recovery quality [23]. The enhanced analgesia provided by the RAG technique likely reduced the need for systemic analgesics, minimizing potential side effects such as nausea, sedation, or gastrointestinal discomfort, further contributing to the positive patient-reported outcomes.

The analysis of postoperative complications underscores the safety profile of the Brachial Plexus + Cutaneous Blocks group (RAG) compared to the Conventional Anesthesia group (CAG). Respiratory depression, a significant concern in perioperative care, was observed only in the CAG group (6%), with no cases in the RAG group. While this difference did not achieve statistical significance ($p = 0.08$), the absence of respiratory depression in the RAG group is clinically meaningful, particularly in high-risk populations. These findings are consistent with prior studies indicating that regional anesthesia minimizes respiratory complications by reducing systemic opioid requirements [24].

Nausea, a common adverse effect of general anesthesia and opioid use, was reported in both groups, albeit less frequently in the RAG group (10% vs. 20%, p = 0.16). Though not statistically significant, the trend towards reduced nausea in the RAG group aligns with the literature suggesting that regional blocks lower the risk of postoperative nausea and vomiting (PONV) due to decreased systemic exposure to anesthetic agents [25].

Prolonged recovery, defined as delayed discharge from the post-anesthesia care unit, occurred more frequently in the CAG group (14%) compared to the RAG group (6%, p = 0.18). While this difference was not significant, the trend suggests a faster initial recovery in patients undergoing regional anesthesia, potentially attributable to its limited systemic effects [26]. Importantly, wound infection rates were identical across groups (2%, p = 1.00), confirming that neither anesthetic technique compromised surgical site outcomes.

The mean length of hospital stay was significantly shorter in the RAG group (2.8 ± 0.7 days) compared to the CAG group (3.4 ± 1.0 days, p < 0.01). This faster recovery in the RAG group likely reflects the superior pain management and reduced incidence of systemic complications, which can delay mobilization and discharge. A shorter hospital stay not only benefits patient satisfaction but also has substantial implications for healthcare cost savings and resource allocation [27].

The reduced use of supplemental analgesics in the RAG group (20% vs. 50%, p < 0.001) further supports the efficacy of regional anesthesia in providing superior pain control. By directly targeting the surgical site, brachial plexus and cutaneous nerve blocks reduce the reliance on systemic analgesics, mitigating their associated adverse effects such as PONV and sedation [28].

The requirement for ultrasonographic guidance in 80% of RAG cases reflects the technical demands of regional anesthesia. Although this adds procedural complexity and requires specialized training, the significant reductions in hospital stay and analgesic use may offset these additional resource requirements in the broader healthcare context [29].

Clinical Implications

This study highlights the superior benefits of brachial plexus and cutaneous nerve blocks over conventional anesthesia, demonstrating better postoperative pain control, higher patient satisfaction, and enhanced safety, without compromising intraoperative outcomes. These findings support the growing preference for regional anesthesia in orthopedic surgeries, reducing opioid dependence and accelerating recovery [30]. Additionally, shorter hospital stays and reduced supplemental analgesic use enhance efficiency and cost-effectiveness, contributing to improved resource utilization [31]. The incorporation of ultrasonographic guidance further optimizes regional anesthesia, making it a viable option for broader clinical adoption, particularly in settings with trained personnel.

Limitations

While the study provides valuable insights, certain limitations warrant consideration. The sample size of 100 patients, though sufficient for detecting differences in pain and satisfaction, may lack the power to assess rarer outcomes or subgroup effects. Furthermore, the study does not provide long-term follow-up data, which would be critical for evaluating sustained benefits or delayed complications. Additionally, the requirement for specialized equipment and expertise for regional anesthesia may limit its generalizability to all surgical centers.

CONCLUSION

Overall, the findings suggest that Brachial Plexus + Cutaneous Blocks offer superior pain control and patient satisfaction, along with a shorter hospital stay, without compromising safety. However, the logistical demands of the technique and the need for ultrasonographic guidance may limit its widespread applicability. Future research should explore cost-effectiveness, long-term outcomes, and the scalability of this approach in diverse healthcare settings to solidify its role in clinical practice.

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