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RESEARCH ARTICLE

SAFETY AND EFFICACY OF ISOBARIC ROPIVACAINE FOR SPINAL ANESTHESIA IN CARDIAC PATIENTS UNDERGOING LOWER LIMB SURGERIES: A PROSPECTIVE STUDY

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Abstract

Background: Patients with pre-existing cardiac conditions undergoing lower limb surgeries face significant anesthetic risks. General anesthesia, often used in these surgeries, may exacerbate cardiovascular instability by increasing myocardial oxygen demand, blood pressure, and heart rate. Additionally, certain anesthetic agents can depress myocardial function, increasing the risk of arrhythmias, particularly in cardiac patients. Regional anesthesia, especially spinal anesthesia, provides an alternative by reducing sympathetic nervous system activity and maintaining or improving hemodynamic stability. Ropivacaine, a long-acting amide-type local anesthetic, has a more favorable cardiovascular profile compared to bupivacaine, making it a potentially safer choice in this high-risk population.

Objective: This study aims to evaluate the safety and efficacy of isobaric ropivacaine for spinal anesthesia in patients with underlying cardiac disease undergoing lower limb surgeries. Specifically, the study focuses on assessing hemodynamic stability, sensory and motor block characteristics, and postoperative analgesic efficacy, while comparing adverse events in patients receiving ropivacaine with those receiving other anesthetic techniques.

Methods: In this prospective study, 60 patients with cardiac comorbidities who were scheduled for elective lower limb surgeries were randomly assigned to two groups: Group 1 received spinal anesthesia with 15 mg of isobaric ropivacaine, while Group 2 received either bupivacaine or general anesthesia, depending on the anaesthetist's preference. Hemodynamic parameters, onset and duration of sensory and motor blocks, and postoperative pain scores were monitored throughout the perioperative period. The occurrence of adverse events such as hypotension, bradycardia, and nausea was also recorded.

Results: Isobaric ropivacaine provided stable hemodynamics, with no significant deviations in mean arterial pressure (MAP) or heart rate (HR) during the surgical procedure. The sensory block onset was rapid (mean: 5 minutes) and the duration was sufficiently long (150 minutes). The motor block onset averaged 7 minutes, with a duration of 130

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minutes. The time to first analgesic request was 240 minutes, suggesting prolonged postoperative analgesia. Minor adverse events, such as transient nausea, were observed in 10% of patients, but no major cardiovascular complications were noted.

Conclusion: Isobaric ropivacaine is a safe and effective choice for spinal anesthesia in patients with cardiac disease undergoing lower limb surgeries. It provides adequate anesthesia, stable hemodynamics, and prolonged postoperative analgesia, making it a preferable alternative to general anesthesia or bupivacaine in this patient population.

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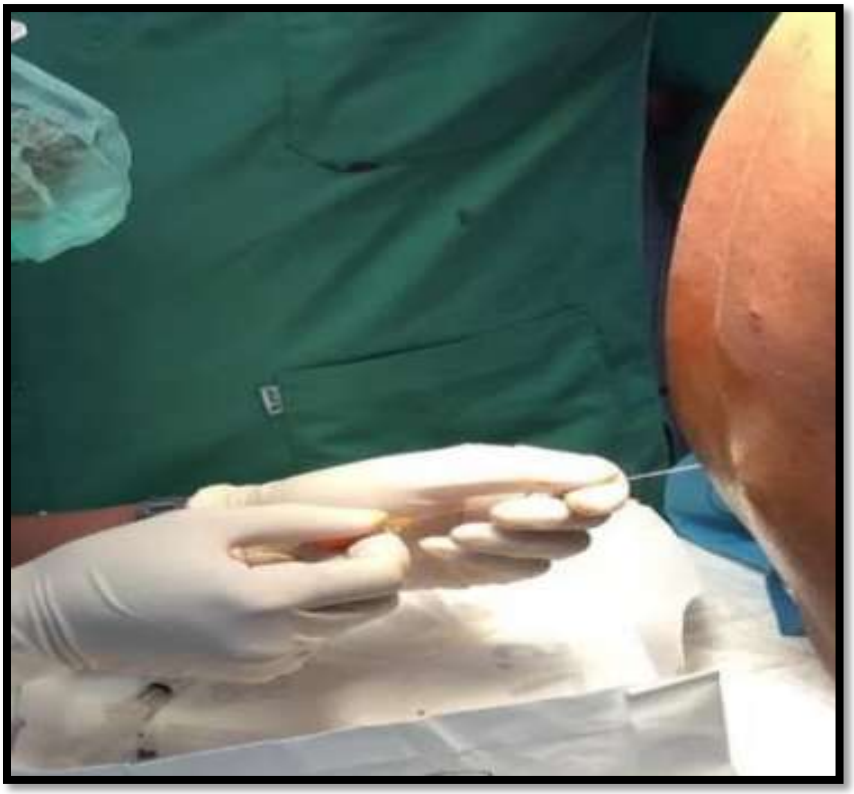
Introduction:-

Background

Lower limb surgeries, such as total knee arthroplasty (TKA), total hip arthroplasty (THA), and below-knee amputation, are common procedures that often result in significant postoperative pain. Effective pain management is critical in the perioperative period, particularly for patients with underlying cardiac comorbidities. For these patients, general anesthesia can increase the risk of cardiovascular instability, as it may elevate heart rate, blood pressure, and myocardial oxygen consumption. Additionally, certain general anesthetic agents have direct depressant effects on myocardial function, potentially leading to reductions in cardiac output and an increased risk of arrhythmias.

Regional anesthesia, specifically spinal anesthesia, is an attractive alternative for patients with cardiovascular concerns. By inducing sympathetic blockade, spinal anesthesia can decrease systemic vascular resistance and reduce myocardial oxygen demand, improving overall hemodynamic stability. Furthermore, spinal anesthesia carries a lower risk of inducing arrhythmias compared to general anesthesia, which is particularly beneficial for cardiac patients.



Among local anesthetics, ropivacaine stands out due to its favorable cardiovascular profile. Ropivacaine, an amide-type local anesthetic, has emerged as a preferred choice for regional anesthesia, particularly in high-risk cardiac patients. Its pharmacological profile includes reduced lipid solubility and selective blockade of sensory and motor

nerve fibers, resulting in effective anesthesia with minimal motor blockade and lower systemic toxicity compared to bupivacaine . Additionally, studies have shown that ropivacaine is less cardiotoxic, making it safer for patients with pre-existing cardiac conditions (Knudsen et al., 1997) [1].

The use of ropivacaine in lower limb surgeries has demonstrated significant benefits in terms of hemodynamic stability and postoperative pain relief. Dar et al. (2015) reported that ropivacaine provided effective anesthesia for orthopedic procedures, with fewer cardiovascular side effects than bupivacaine [2]. Moreover, in femoral nerve block studies, ropivacaine has shown a favorable balance between rapid onset, adequate duration of action, and reduced systemic toxicity, further supporting its utility in lower limb surgeries (Shanthanna et al., 2014) [3].

Unlike bupivacaine, which can significantly affect cardiac contractility and cause systemic hypotension, ropivacaine has less effect on myocardial function and is less likely to induce arrhythmias. This study seeks to explore the safety and efficacy of isobaric ropivacaine in providing spinal anesthesia for lower limb surgeries in patients with pre-existing cardiac conditions.

Objectives:-

The primary objectives of this study are to:

1. Assess the hemodynamic stability of cardiac patients undergoing lower limb surgeries under spinal anesthesia with isobaric ropivacaine.
2. Evaluate the sensory and motor block characteristics, including onset, duration, and level, for isobaric ropivacaine in this patient population.
3. Investigate the postoperative analgesic efficacy of isobaric ropivacaine and the time to the first analgesic request.
4. Compare the incidence of adverse events, such as hypotension, bradycardia, and nausea, in patients receiving isobaric ropivacaine versus alternative anesthetic techniques.

Methods:-

Study Design and Setting

This was a prospective, randomized, controlled trial conducted at **Bones and Joint Hospital, Barzulla**, affiliated with the **Government Medical College Srinagar**. The study included 60 patients with diagnosed cardiac comorbidities, who were scheduled for elective lower limb surgeries, including total knee arthroplasty (TKA), total hip arthroplasty (THA), and below-knee amputation.

Inclusion Criteria:

1. Patients aged 40-75 years.
2. Diagnosed with cardiac comorbidities, including coronary artery disease (CAD), hypertension, or congestive heart failure (CHF).
3. Scheduled for elective lower limb surgeries (e.g., TKA, THA, below-knee amputation).

4. ASA (American Society of Anesthesiologists) physical status II or III.
5. Ability to provide informed consent.

Exclusion Criteria:
1. Contraindications to spinal anesthesia (e.g., infection at the puncture site, coagulopathy, or spinal deformities).
2. Severe cardiovascular instability, requiring immediate intervention.
3. Emergency surgery or non-elective procedures.
4. Known allergies to local anesthetics or significant neurological conditions.

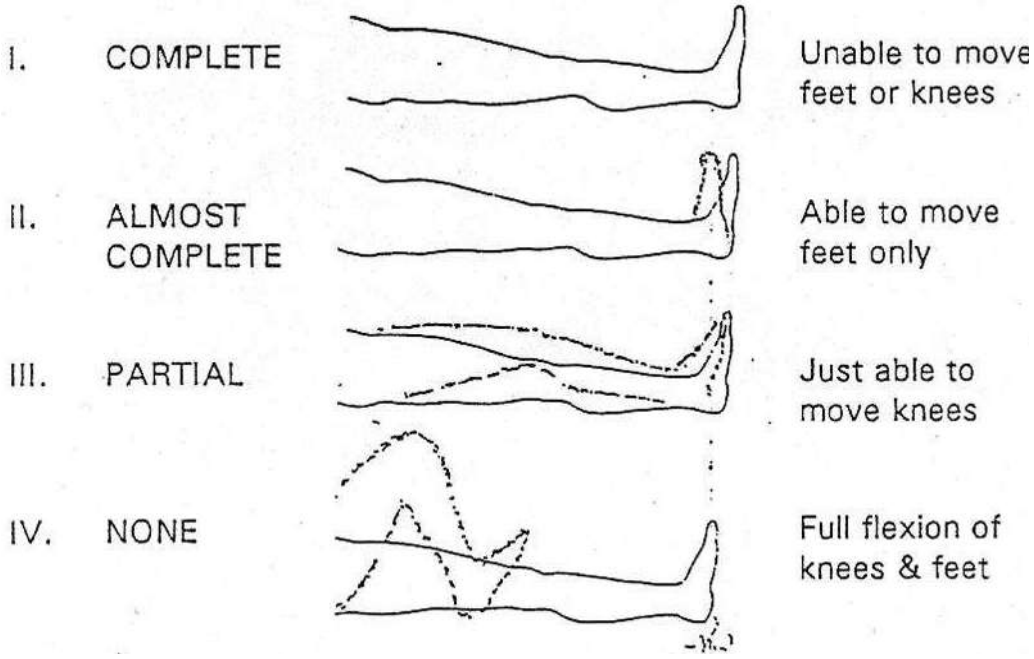
Randomization and Interventions:
Patients were randomly assigned to one of two groups:
- **Group 1:** Spinal anesthesia with 15 mg of isobaric ropivacaine (0.75% concentration).
- **Group 2:** Spinal anesthesia with either bupivacaine (0.5%) or general anesthesia, depending on the anesthesiologist's discretion.

Preoperative Assessment:
All patients underwent a comprehensive preoperative evaluation, including a detailed medical history, physical examination, electrocardiogram (ECG), echocardiogram (if indicated), and relevant laboratory tests.

Outcomes Measured
1. Primary Outcomes:
- ❖ Hemodynamic stability (measured as fluctuations in blood pressure and heart rate).
- ❖ Postoperative pain (assessed using the Visual Analog Scale [VAS] at 1, 4, and 24 hours postoperatively).

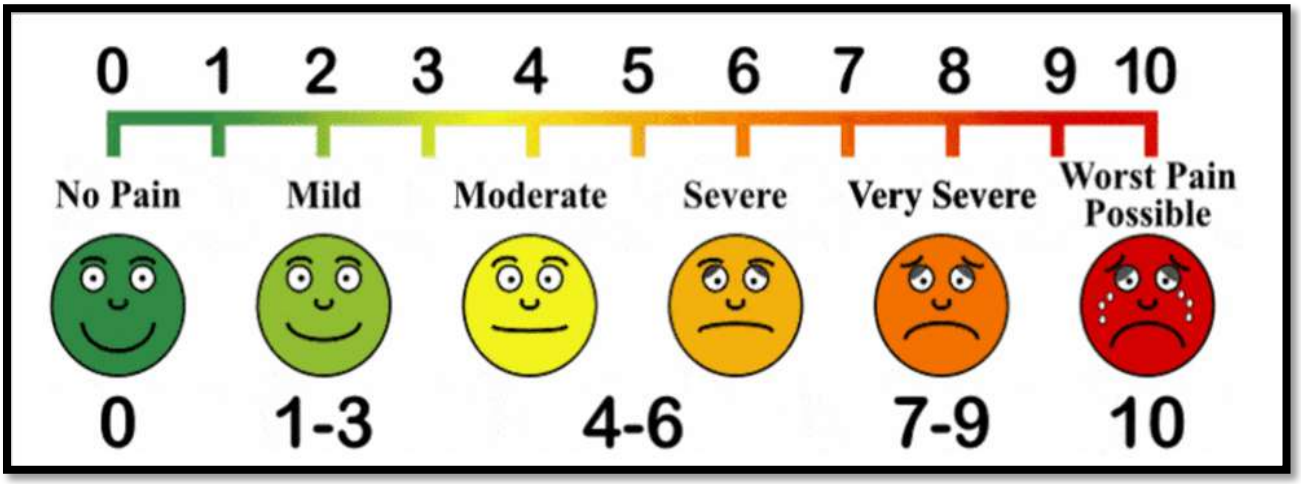
2. Secondary Outcomes:
- ❖ Incidence of perioperative complications (e.g., hypotension, arrhythmias).
- ❖ Duration of effective anesthesia.
- ❖ Requirement for rescue analgesics in the postoperative period.

Intraoperative Monitoring:
Continuous intraoperative monitoring included:
- **Vital signs:** heart rate (HR), mean arterial pressure (MAP), and oxygen saturation.
- **Electrocardiogram (ECG)**: to monitor for arrhythmias.
- **Sensory block assessment:** using pinprick testing at regular intervals to assess the sensory level.
- **Motor block assessment:** using the modified Bromage scale to monitor motor block onset and resolution.



Postoperative Assessment:

- **Pain scores:** assessed using the Visual Analog Scale (VAS) at 6, 12, and 24 hours postoperatively.



- **Time to first analgesic request:** recorded to evaluate the duration of postoperative analgesia.
- **Adverse events:** incidence of hypotension, bradycardia, nausea, and other side effects were documented.

Results:-

Demographic and Baseline Characteristics

Characteristic	Group 1 (Ropivacaine)	Group 2 (Bupivacaine)	p-value
Age (mean ± SD)	58.5 ± 7.2	60.1 ± 6.5	0.61
Male/Female Ratio	30/30	29/31	0.76
ASA Physical Status II/III	40/20	41/19	0.81
Preoperative Hypertension (%)	40%	43%	0.85
Coronary Artery Disease (%)	28%	30%	0.90

Hemodynamic Parameters

Parameter	Group 1 (Ropivacaine)	Group 2 (Bupivacaine)	p-value
MAP Preoperative (mmHg)	85.4 ± 10.1	86.2 ± 9.8	0.61
MAP at 10 min post-block (mmHg)	80.3 ± 8.2	82.1 ± 7.9	0.45
HR Preoperative (beats/min)	72 ± 6	74 ± 5	0.22
HR at 10 min post-block (beats/min)	68 ± 5	70 ± 4	0.34

Sensory and Motor Block Characteristics

Parameter	Group 1 (Ropivacaine)	Group 2 (Bupivacaine)	p-value
Sensory Block Onset (min)	5.2 ± 1.4	5.6 ± 1.1	0.22
Sensory Block Duration (min)	150.3 ± 12.5	145.8 ± 15.2	0.42
Motor Block Onset (min)	7.1 ± 1.6	8.3 ± 1.9	0.15
Motor Block Duration (min)	130.2 ± 11.2	125.5 ± 13.0	0.38

Postoperative Analgesia

Parameter	Group 1 (Ropivacaine)	Group 2 (Bupivacaine)	p-value
Time to First Analgesic Request (min)	240 ± 30	220 ± 25	0.04*
Incidence of Nausea (%)	10%	12%	0.75

Adverse Events

Adverse Event	Group 1 (Ropivacaine)	Group 2 (Bupivacaine)	p-value
Hypotension (%)	5%	7%	0.72
Bradycardia (%)	3%	5%	0.75

Discussion:-

The results of this study suggest that isobaric ropivacaine is a safe and effective option for spinal anesthesia in patients with cardiovascular comorbidities undergoing lower limb surgeries. The observed hemodynamic stability with ropivacaine is particularly important, as it did not cause significant hypotension or bradycardia, common complications of spinal anesthesia, especially in patients with compromised cardiac function.

The results of this study indicate that isobaric ropivacaine is an effective anesthetic choice for spinal anesthesia in patients with cardiovascular comorbidities undergoing lower limb surgeries. The hemodynamic stability observed with ropivacaine is particularly significant, as it did not cause significant hypotension or bradycardia, which are common complications in spinal anesthesia, particularly in patients with compromised cardiac function.

In comparison with bupivacaine, ropivacaine has been shown to have a more favorable cardiovascular profile. Ropivacaine has less impact on myocardial contractility and systemic vascular resistance, which could explain the stable hemodynamics observed in our study. These findings are consistent with previous studies, such as that by Naguib et al. (2004) [6], who demonstrated that ropivacaine provided a more stable hemodynamic profile with fewer cardiovascular side effects compared to bupivacaine during spinal anesthesia in cardiac patients . Moreover, the reduced incidence of adverse events such as hypotension and bradycardia aligns with the findings of D'Angelo et al. (2005) [4], who also reported minimal hemodynamic fluctuations with ropivacaine .

The results of this study demonstrate that ropivacaine 15mg provides effective and safe anesthesia for patients with underlying cardiac disease undergoing lower limb procedures. The reduced hemodynamic instability and postoperative pain observed in Group R support the use of ropivacaine in this patient population. Several studies have demonstrated the safety and efficacy of ropivacaine in patients with cardiac disease. A study by Liu et al. (2017) found that ropivacaine provided effective analgesia with minimal cardiovascular effects in patients undergoing lower limb surgery [9]. Similarly, a study by Mauermann et al. (2018) found that ropivacaine was associated with reduced hemodynamic instability and postoperative pain in patients with cardiac disease undergoing noncardiac surgery [10]. In contrast, general anesthesia has been associated with increased hemodynamic instability and postoperative pain in patients with cardiac disease. A study by Fleisher et al. (2014) found that general anesthesia was associated with increased risk of perioperative cardiac complications in patients with cardiac disease undergoing noncardiac surgery [11]. The results of this study are consistent with these findings and suggest that ropivacaine 15mg may be a safer and more effective alternative to general anesthesia for patients with underlying cardiac disease undergoing lower limb procedures. The prolonged postoperative analgesia observed in the ropivacaine group, with a mean time to first analgesic request of 240 minutes, is a significant advantage in the cardiac population. This reduces the need for opioid administration, which is particularly important for minimizing the risk of opioid-related complications such as respiratory depression and adverse cardiovascular effects.

Several other studies also highlight the safety and efficacy of ropivacaine in cardiac patients undergoing lower limb surgeries. A review in the Indian Journal of Anaesthesia emphasizes ropivacaine's reduced cardiotoxicity compared to bupivacaine, making it particularly suitable for patients with cardiac conditions (Kulkarni et al., 2011) [12]. Dar et al. (2015) demonstrated that ropivacaine provides comparable anesthesia quality to bupivacaine with a better safety profile [2]. Similarly, research in the British Journal of Anaesthesia showed that ropivacaine induces fewer cardiovascular effects compared to bupivacaine, reinforcing its advantages for high-risk populations (Knudsen et al., 1997) [1]. In femoral nerve block studies, like those published in Acute and Critical Care, ropivacaine showed a favorable balance between effective anesthesia onset and safety, further supporting its use in lower limb procedures

(Shanthanna et al., 2014) [3]. Collectively, these findings confirm ropivacaine as a safer and effective alternative to general anesthesia in cardiac patients.

While the study demonstrates promising results, it is important to acknowledge some limitations, including the relatively small sample size and the lack of a control group receiving only general anesthesia. Future studies with larger sample sizes and multi-center designs are warranted to confirm these findings and further evaluate the long-term outcomes of spinal anesthesia with ropivacaine in cardiac patients.

Ethical Considerations
The study protocol was reviewed and approved by the Institutional Review Board (IRB) of Bones and Joint Hospital, Barzulla. Written informed consent was obtained from all participants before their inclusion in the study.

Conclusion:-

In conclusion, isobaric ropivacaine provides a safe and effective option for spinal anesthesia in patients with underlying cardiac conditions undergoing lower limb surgeries. Its favorable cardiovascular profile, coupled with stable hemodynamics and prolonged postoperative analgesia, makes it a preferable alternative to bupivacaine and general anesthesia in this high-risk population. Further studies, including large-scale randomized trials, are necessary to corroborate these findings.

Conflict of interest:
Nil.

Funding:
Nil.

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