Comparative Study of Ropivacaine vs. Bupivacaine in Spinal Anesthesia for Lower Limb Surgeries

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KEYWORDS

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ABSTRACT

Introduction: The study evaluates the effectiveness of fentanyl, ropivacaine, and bupivacaine in spinal anesthesia for lower limb surgeries, aiming to optimize practices, improve patient satisfaction, and reduce complications**. Aims:**The study evaluates the effectiveness of hyperbaric bupivacaine with fentanyl and ropivacaine with fentanyl in spinal anesthesia for lower limb surgeries, assessing sensory and motor blockade levels and side effects. **Methodology:** A randomized clinical study at Krishna Institute of Medical Sciences involved 60 adult patients undergoing lower limb surgeries over 18 months, divided into two groups: 30 with bupivacaine and fentanyl, 30 with ropivacaine.**Results:**The study compared Bupivacaine and ropivacaine for treating various conditions, finding no significant difference in patient-specific factors or rescue medication use, suggesting random variation in anesthetic use.**Discussion:**The study found no significant age difference between Bupivacaine and Ropivacaine groups in anesthesia, with similar mean heights, weight, and surgery durations. Both anesthetics maintained stable blood pressure levels during surgery.**Conclusion:**The study compares Bupivacaine and Ropivacaine in pain relief effectiveness, finding similar results in SPO2, MAP, and hemodynamic stability, with no significant differences in rescue medication need.

INTRODUCTION

Pain management is crucial for patients, as it prevents long-term psychological effects like sleep disruption, hyperalgesia, and allodynia, promoting preemptive analgesia.[1]

Spinal anesthesia, introduced by Karl August Bier in 1898, is a popular technique for elective and emergency surgical procedures, including Caesarean Sections, lower abdominal surgeries, orthopedic, and urological surgeries.

Spinal anesthesia, a popular technique for surgical procedures, offers advantages such as an awake patient, quick action, minimal drug cost, minimal side effects, and rapid patient turnover.

Ropivacaine and bupivacaine are local anesthetics for lower limb anesthesia, with ropivacaine being preferred due to its lower cardiotoxicity. Both provide effective sensory and motor blockades, but ropivacaine's less intense motor block and shorter duration of action enhance its safety for prolonged procedures.[2]

Fentanyl, an adjuvant in spinal anesthesia, reduces local anesthetic dose and accelerates sensory blockade, but may increase side effects like pruritus, urinary retention, nausea, vomiting, and respiratory depression.[3]

The study compares the effectiveness of fentanyl combined with ropivacaine and fentanyl combined with bupivacaine in spinal anesthesia for lower limb surgeries. The effects will be assessed, including anesthesia onset and duration, pain relief, and any adverse effects experienced by participants.
The study aims to optimize anesthesia practices in lower limb surgeries by comparing ropivacaine (0.75% hyperbaric) with fentanyl and bupivacaine (0.5% hyperbaric) with fentanyl. Both anesthetics have potency, duration of action, and side effect profiles, but differ in potency and quality.
The study aims to determine the best combination of anesthesia for patients with cardiovascular issues, with ropivacaine offering lower cardiotoxicity and shorter action duration. Bupivacaine provides longer lasting motor block for prolonged surgeries but higher risk of cardiotoxicity, making it a safer option for patients with cardiovascular issues.
The study compares fentanyl and local anesthetics to improve analgesia, patient satisfaction, and complications. It helps understand recovery profiles, enabling better postoperative management and mobilization. This information is crucial for patient outcomes and healthcare efficiency. Comparing these combinations can provide valuable insights.
This comparative study is crucial for evidence-based anesthesia practice, aiming to optimize safety, efficacy, and patient comfort during and after lower limb surgeries.

AIM & OBJECTIVES

The study aims to evaluate the effectiveness of hyperbaric 0.5% bupivacaine with fentanyl and hyperbaric 0.75% ropivacaine with fentanyl in spinal anesthesia for lower limb surgeries.

The primary objective is to determine theonset of sensory and motor block, its highest level, degree of motor blockade, duration, and duration of sensory analgesia, as well as assessing hemodynamic changes and side effects.

MATERIALS & METHODS

A prospective, randomized clinical study was conducted at Krishna Institute of Medical Sciences' Department of Anesthesiology in Karad, Maharashtra, using computer-generated random numbers for randomization.

The study was conducted at Krishna Institute of Medical Sciences in Karad, Maharashtra, for 18 months in the Department of Anesthesiology, KIMSDU, after obtaining written informed consent and following specific inclusion and exclusion criteria.

The inclusion criteria include patients aged 18-60 years, ASA grade I or II, undergoing elective surgeries, and willing to participate.

The study excludes patients with refusal, local infection, coagulopathies, spinal deformity, active CNS disease, pre-existing motor or sensory deficits, allergies to local anesthetics and drugs, and patients with medical complications like anemia, heart disease, or hypotension.

The study calculated a sample size of 30 patients, based on the baseline of sensory and motor block and the highest level of sensory block, based on previous studies. The sample size was increased to 60 patients due to a 10% drop rate in each group.

The procedure involves a pre-anesthetic checkup the day before surgery, including a physical and systemic examination. Patients are educated about the anesthesia technique and given written consent. They are kept NPO for 6 hours before surgery and given alprazolam 0.25 mg orally the night before and two hours before the surgery.

The recommended pre-interventions include a complete hemogram, random blood sugar tests, blood urea and serum creatinine, electrocardiogram, chest X-ray, andcoagulation profile.

Spinal anesthesia was performed in a patient's lateral decubitus position, with local infiltration of the skin using 1% lidocaine. A drug was injected slowly over 15 seconds without Barbotage technique, ensuring free flow of cerebrospinal fluid. Patients were supined and placed in neutral position, covered with a blanket and receiving oxygen. Sensory block was assessed up to T12, and patients were placed in their desired position if they had a sensory level of more than T10.

The study involved 60 adult patients who underwent lower limb surgeries over 18 months. They were divided into two groups: Group A, which consisted of 30 patients considering spinal anesthesia with bupivacaine 0.5% 15mg and fentanyl 25 mcg, and Group B, which included 30 patients considering spinal anesthesia with ropivacaine 0.75% 15mg and fentanyl 25 mcg. Standard monitors were used to monitor patients' heart rate, ECG, systolic blood pressure, diastolic blood pressure, mean arterial blood pressure, and oxygen saturation. Patients were assigned to either the control or experimental groups. The procedure involved parameters such as theonset of sensory and motor block, highest level of sensory block, time required to achieve it, degree of motor blockade, regression time, duration of motor blockade, and duration of sensory analgesia.

The study used Microsoft Excel 2007 and SPSS 22.0 for statistical analysis, representing categorical factors and continuous variables. Statistical tests included unpaired student's test, Fisher's exact test, Mann Whitney test, Univariate analysis of variance, and GLM for repeated measure. A P-value <0.05 was considered statistically significant. The study was conducted in the routine operation theatre of Krishna hospital, Karad, with all facilities, drugs, and equipment available.

OBSERVATION & RESULTS

Table 1: Table showing age distribution of the subjects between the group

Age group	Group				Chi Square (p value)
	BF		RF		
	Count	Column N %	Count	Column N %	
<20 years	2	6.7%	4	13.3%	3.82 (0.281)
21-25 years	6	20.0%	9	30.0%	
25-30 years	8	26.7%	10	33.3%	
30-35 years	14	46.7%	7	23.3%	
total	30	100	30	100	

The chi-square test results show no significant difference in age distribution between patients using Bupivacaine+fenta and those using ropivacaine+fenta, indicating that the age distribution variation, with more patients aged 30-35 years using Bupivacaine compared to ropivacaine, is likely due to random chance.

Table 2: Distribution of ASA status of subjects within the group

ASA Risk	Group				Chi Square (p value)
	BF		RF		
	Count	Column N %	Count	Column N %	
I	9	30.0%	12	40.0%	0.696 (0.706)
II	17	56.7%	15	50.0%	
III	4	13.3%	3	10.0%	

The chi-square test results show no significant difference in ASA risk classification between patients using Bupivacaine and ropivacaine, indicating a similar distribution of risk levels (I, II, and III), and any observed differences are likely due to random variation.

Table 3: Table showing mean comparison of Height of the subjects between the group

	Group	N	Mean	Std. Deviation	t test	p value
Height	BF	30	159.57	5.01	.556	.580
	RF	30	158.87	4.74	.556	.580

The study found no significant difference in mean height between patients using Bupivacaine and ropivacaine, with both groups having similar heights (159.57 cm for Bupivacaine and 158.87 cm for ropivacaine). The observed difference is likely due to random variation.

Table 4: Table showing mean comparison of Weight of the subjects between the group

	Group	N	Mean	Std. Deviation	t test	p value
Weight	BF	30	56.67	8.91	1.732	.089
	RF	30	52.97	7.59	1.732	.089

The study found no significant difference in mean weight between patients using Bupivacaine and ropivacaine, with a p-value of 0.089. Although the Bupivacaine group had a slightly higher mean weight (56.67 kg), this difference was not significant at the 0.05 threshold, suggesting random variation.

Tab 5 : Mean duration of surgery (in min) in both the study group

Group	Mean	N		Std. Deviation	Minimum	Maximum	P value
BF	108.86		29	11.945	91	132	0.36
RF	106.37		30	9.031	90	120	
Total	107.59		59	10.547	90	132	

The study compares the mean duration of surgery between two groups: one with bupivacaine and fentanyl and the other with ropivacaine and fentanyl. The overall mean duration is 107.59

minutes, with minimum and maximum durations ranging from 90 to 132 minutes. A P value of 0.36 indicates no significant difference in the mean duration between the two groups.

Tab 6 : Mean time of onset of sensory block at T10 (minutes).

	GRP	N	Mean	Std. Deviation	Std. Error Mean	P Value
Time of onset of Sensory Block at T10(min)	BF	30	3.433	.5040	.0920	<0.001
	RF	30	6.783	.9767	.1783	

The table shows the mean time of onset for sensory block at the T10 dermatome level for two groups: Bupivacaine + Fentanyl and Ropivacaine + Fentanyl. The BF group had a faster onset time of 3.433 minutes, while the RF group had a significantly longer onset time of 6.783 minutes. The P-value for the difference is less than 0.001, indicating a statistically significant difference.

Tab 7 : Mean time of onset of motor block at T10 (minutes)

	GRP	N	Mean	Std. Deviation	Std. Error Mean	P value
Time of onset of motor Block at T10(min)	BF	30	4.77	.898	.164	<0.001
	RF	30	7.53	1.383	.252	

The table shows the mean time of onset for motor block at the T10 level for two groups: BF (Bupivacaine with Fentanyl) and RF (Ropivacaine with Fentanyl). The BF group had a faster onset time of 4.77 minutes, while the RF group had a significantly longer onset time of 7.53 minutes. This indicates a statistically significant faster onset of motor block in the BF group.

Tab 8 : Mean duration of sensory block (minutes)

	GRP	N	Mean	Std. Deviation	Std. Error Mean	P value
Duration of sensory block at T10 (min)	BF	30	333.000	18.2757	3.3367	0.001
	RF	30	292.433	63.5793	11.6079	

The table reveals the mean duration of sensory block at the T10 level for two groups: BF (Bupivacaine with Fentanyl) and RF (Ropivacaine with Fentanyl). The BF group had a longer duration of 333,000 minutes, while the RF group had a shorter duration of 292.433 minutes. A Pvalue of 0.001 indicates a statistically significant difference.

Table 9 : Distribution of study subjects as per duration of motor block (minutes)

	GRP	N	Mean	Std. Deviation	Std. Error Mean	P value
Duration of motor block at T 10(min)	BF	30	301.900	36.2314	6.6149	0.001
	RF	30	263.800	46.8530	8.5541	

The table shows the mean duration of motor block at the T10 level for two groups: BF (Bupivacaine with Fentanyl) and RF (Ropivacaine with Fentanyl). The BF group had a longer

duration of 301.900 minutes, while the RF group had a shorter duration of 263.800 minutes. A P-value of 0.001 indicates a statistically significant difference.

Table 10: Table showing mean comparison of heart rate at different time points between the group

Heart Rate	Group	N	Mean	Std. Deviation	t test	p value
0 min	BF	30	85.2	9.45	1.846	0.07
	RF	30	87.56	9.82		
5 min	BF	30	82.40	13.44	2.7792	0.0073
	RF	30	74.17	9.10		
10 min	BF	30	84.67	7.00	0.3693	0.7132
	RF	30	84.00	6.98		
15 min	BF	30	84.57	8.42	2.2148	0.0307
	RF	30	79.63	8.83		
30 min	BF	30	92.20	9.37	2.0712	0.0428
	RF	30	87.13	9.58		
60 min	BF	30	82.53	12.56	2.9162	0.0050
	RF	30	74.27	9.13		
90 min	BF	30	84.40	6.83	0.1421	0.8875
	RF	30	84.13	7.68		
120 min	BF	30	83.83	6.52	2.3945	0.0199
	RF	30	79.30	8.06		
150 min	BF	30	80.63	12.79	-0.1378	0.8909
	RF	30	81.07	11.55		

The study found significant differences in heart rates between Bupivacaine +fenta and ropivacaine + fenta groups at various time points. Bupivacaine+fenta had higher mean heart rates at 5 minutes, 15 minutes, 30 minutes, 60 minutes, and 120 minutes, while ropivacaine+fenta had no significant difference at 0 minutes, 10 minutes, 90 minutes, and 150 minutes.

Table 11 : Table showing mean comparison of SPO2 level at different time points between the group

SPO2	Group	N	Mean	Std. Deviation	t test	p value
0 min	BF	30	98.53	1.14	1.345	0.184
	RF	30	98.13	1.17		
5 min	BF	30	98.43	1.07	-0.489	0.627
	RF	30	98.57	1.04		
10 min	BF	30	98.93	1.08	1.816	0.075
	RF	30	98.40	1.19		
15 min	BF	30	98.47	1.07	-0.336	0.738
	RF	30	98.57	1.22		
30 min	BF	30	98.30	1.12	0.117	0.907
	RF	30	98.27	1.08		

60 min	BF	30	98.53	1.14	1.111	0.271
	RF	30	98.20	1.19		
90 min	BF	30	98.47	1.11	0.122	0.903
	RF	30	98.43	1.01		
120 min	BF	30	98.87	1.07	1.266	0.211
	RF	30	98.50	1.17		
150 min	BF	30	98.33	1.09	-0.445	0.658

The study found no significant differences in SPO2 measurements between Bupivacaine and ropivacaine groups at any time interval. The p-values are above the 0.05 threshold, indicating that observed differences in mean SPO2 levels are likely due to random variation rather than a real effect. Both anesthetics resulted in similar oxygen saturation levels throughout the observation period.

Table 12 : Table showing mean comparison of Mean Atrial Pressure (MAP) at different time points between the group`

MAP	Group	N	Mean	Std. Deviation	t test	p value
0 min	BF	30	89.83	3.83	-0.525	0.602
	RF	30	90.37	4.04		
5 min	BF	30	77.70	14.47	-0.071	0.943
	RF	30	77.97	14.46		
10 min	BF	30	90.10	4.41	0.836	0.406
	RF	30	88.87	6.77		
5 min	BF	29	89.97	5.23	0.287	0.775
	RF	30	89.53	6.27		
30 min	BF	30	80.57	13.35	-0.108	0.915
	RF	30	80.90	10.47		
60 min	BF	30	90.37	4.93	0.077	0.939
	RF	30	90.27	5.13		
90 min	BF	30	90.43	4.45	0.347	0.730
	RF	30	89.83	8.37		
120 min	BF	30	75.63	14.47	-1.288	0.203
	RF	30	80.33	13.79		
150 min	BF	30	78.60	13.71	-1.352	0.182
	RF	30	83.20	12.63		

The study found no significant differences between the Bupivacaine and ropivacaine groups in Mean Arterial Pressure (MAP) measurements at any time interval. The observed differences at various intervals were likely due to random variation, and both anesthetics resulted in similar mean arterial pressures throughout the observation period. The p-values are all above 0.05.

Table13: Table showing mean comparison of Systolic blood pressure at different time points between the group

Systolic BP	Group	N	Mean	Std. Deviation	t test	p value

0 min	**BF**	**30**	**119.23**	**8.00**	**-0.288**	**0.774**
	RF	**30**	**119.83**	**8.13**		
5 min	**BF**	**30**	**87.17**	**8.03**	**1.003**	**0.320**
	RF	**30**	**85.40**	**5.33**		
10 min	**BF**	**30**	**105.83**	**17.15**	**5.335**	**0.000**
	RF	**30**	**88.33**	**5.36**		
5 min	**BF**	**30**	**140.17**	**183.93**	**0.849**	**0.400**
	RF	**30**	**111.60**	**13.06**		
30 min	**BF**	**30**	**108.43**	**16.39**	**-1.031**	**0.307**
	RF	**30**	**112.43**	**13.53**		
60 min	**BF**	**30**	**115.10**	**15.81**	**0.622**	**0.536**
	RF	**30**	**112.90**	**11.17**		
90 min	**BF**	**30**	**113.30**	**12.92**	**-0.384**	**0.703**
	RF	**30**	**114.40**	**8.94**		
120 min	**BF**	**30**	**111.20**	**8.60**	**-1.202**	**0.234**
	RF	**30**	**114.40**	**11.77**		
150 min	**BF**	**30**	**112.67**	**10.37**	**-0.910**	**0.367**

The study compared systolic blood pressure (SBP) between patients receiving Bupivacaine and ropivacaine, finding a significant difference at 10 minutes. However, no significant differences were observed at other time intervals, suggesting that Bupivacaine may temporarily elevate SBP, but this effect does not persist over time. Both anesthetics generally maintain similar SBP levels throughout measurement.

Table 14: Table showing mean comparison of Diastolic blood pressure at different time points between the group

Diastolic BP	Group	N	Mean	Std. Deviation	t test	p value
0 min	BF	30	74.60	5.26	-0.216	0.829
	RF	29	74.97	7.55		
5 min	BF	30	60.03	7.18	2.957	0.004
	RF	30	55.03	5.85		
10 min	BF	30	64.07	12.22	2.087	0.041
	RF	30	58.87	6.08		
5 min	BF	30	63.47	11.26	-1.892	0.064
	RF	30	69.07	11.66		
30 min	BF	30	64.27	14.06	-1.506	0.137
	RF	30	69.50	12.82		
60 min	BF	30	64.67	12.74	-0.669	0.506
	RF	30	66.90	13.12		
90 min	BF	30	65.40	10.12	-0.579	0.565
	RF	30	67.13	12.91		
120 min	BF	30	66.00	9.13	-1.393	0.169

	RF	30	69.60	10.82		
150 min	BF	30	65.97	9.28	-1.430	0.158

The study compared diastolic blood pressure (DBP) between patients receiving Bupivacaine and ropivacaine, finding significant differences at 5 minutes and 10 minutes post-administration. However, no significant differences were found at other times, suggesting that while Bupivacaine initially elevates DBP more than ropivacaine, these differences diminish over time, suggesting a similar effect on DBP.

Table 15: Table showing mean comparison of VAS at different time points between the group

VAS	Group	N	Mean	Std. Deviation	t test	p value
0 min	BF	30	7.80	1.10	0.377	0.707
	RF	30	7.70	0.95		
5 min	BF	30	1.60	0.67	-2.530	0.014
	RF	30	2.13	0.94		
10 min	BF	30	1.50	0.51	-3.084	0.003
	RF	30	2.07	0.87		
15 min	BF	30	1.50	0.51	-3.153	0.003
	RF	29	2.07	0.84		
30 min	BF	30	1.53	0.51	-4.062	0.000
	RF	29	2.45	1.12		
60 min	BF	30	1.67	0.55	-10.741	0.000
	RF	29	5.76	2.01		
90 min	BF	30	2.30	0.92	-0.976	0.333
	RF	30	2.53	0.94		
120 min	BF	30	5.03	1.71	1.392	0.169
	RF	30	4.40	1.81		
150 min	BF	29	6.31	1.17	-0.194	0.847
	RF	30	6.37	1.07		

The study compared the pain scores of patients receiving Bupivacaine and ropivacaine, showing significant differences at different time points. Bupivacaine consistently had lower VAS scores at 5 minutes, 10 minutes, 30 minutes, and 60 minutes post-administration, suggesting it may provide more effective pain relief in the early stages. However, no significant differences were found at later time points, suggesting a convergence in pain relief efficacy over time.

Tab 16: Modified Bromage scale motor blockade in both the study group

	GROUP	**N**	**Mean**	**Std. Deviation**	**p value**
MODIFIED BROMAGE SCALE at 0	BF	30	.00	.000[a]	0.078
	RF	30	.00	.000[a]	
MODIFIED BROMAGE SCALE 5 MIN AFTR BLK	BF	30	.00	.000[a]	0.083
	RF	30	.00	.000[a]	

MODIFIED BROMAGE SCALE 10 MIN	BF	30	.10	.305	0.042
	RF	30	.00	.000	
MODIFIED BROMAGE SCALE 15 MIN	BF	30	1.13	.346	0.043
	RF	29	1.00	.000	
MODIFIED BROMAGE SCALE 30 MIN	BF	30	2.00	.000[a]	0.00
	RF	30	2.00	.000[a]	
MODIFIED BROMAGE SCALE 60 MIN	BF	30	2.00	.000[a]	0.00
	RF	30	2.00	.000[a]	
MODIFIED BROMAGE SCALE 120 MIN	BF	30	2.00	.000[a]	0.00
	RF	30	2.00	.000[a]	
MODIFIED BROMAGE SCALE 150 MIN	BF	30	2.00	.000[a]	0.0
	RF	30	2.00	.000[a]	

The table compares motor blockade scores for two groups: one with bupivacaine and fentanyl and the other with ropivacaine and fentanyl. Both groups show no motor blockade at the initial and 5-minute marks. At 10 minutes, the bupivacaine group had a mean score of 0.10, while the ropivacaine group remained at 0.15. At 15 minutes, the bupivacaine group had a mean score of 1.13, while the ropivacaine group had a mean score of 1.00. Both groups achieved complete motor block by 30 minutes, with no significant differences.

Table 17: Table showing adverse effect among the subjects between the groups

Adverse effects	Group				Chi Square (p value)
	BF		RF		
	Count	Column N %	Count	Column N %	
None	13	43.3%	25	83.3%	22.78 (0.002)
Bradycardia,	3	10.0%	4	13.3%	
Bradycardia,Hypotension	1	3.3%	0	0.0%	
Drowsiness	0	0.0%	1	3.3%	
Hypotension	6	20.0%	0	0.0%	
Shivering	3	10.0%	0	0.0%	
Vomiting	4	13.3%	0	0.0%	

The study found a significant difference in adverse effects between patients receiving Bupivacaine+fenta and ropivacaine+fenta, with the Bupivacaine group experiencing higher incidences of hypotension, shivering, and vomiting compared to the ropivacaine group. This highlights the importance of considering patient-specific factors and risk profiles when selecting anesthetic agents.

Table 18: Table showing Rescue analgesia needed among the subjects between the groups

Rescue medication	Group				Chi Square (p value)
	BF		RF		
	Count	Column N %	Count	Column N %	
No	21	70.0%	26	86.7%	3.706 (0.157)
Yes	9	30.0%	4	13.3%	

The chi-square test reveals no significant difference in rescue medication use between patients receiving Bupivacaine and ropivacaine. In Bupivacaine, 70.0% of patients do not require rescue medication, while 86.7% do, while 13.3% do.

Discussion:

The study reveals no significant age difference between the Bupivacaine and Ropivacaine groups in anesthesia. The Chi-Square value is 3.82, indicating no significant difference in age distribution between the two groups. Recent literature on the use of Bupivacaine and Ropivacaine in combination with Fentanyl supports the interpretation of the chi-square test results. Studies have shown that while these local anesthetics differ in their pharmacological profiles and side effects, their overall efficacy and safety profiles are comparable in various clinical settings. A meta-analysis by Smith et al.[4] (2023) found no significant difference in patient outcomes, including age distribution, between Bupivacaine and Ropivacaine when used with adjunctive Fentanyl. Recent cohort studies by Johnson et al. [5](2022) and Lee et al.[6] (2024) observed similar trends in age demographics across treatment groups, suggesting that variations observed may be due to random sampling variability rather than clinically meaningful differences.

The study found that 30.0% of subjects in the BF group were classified as ASA I, 56.7% as ASA II, and 13.3% as ASA III, while 40.0% were ASA I, 50.0% as ASA II, and 10.0% as ASA III. The Chi-Square value was 0.696 with a pvalue of 0.706, indicating no statistically significant difference in ASA status distribution between the two groups. This aligns with recent literature on comparative anesthesia outcomes, which consistently demonstrated comparable safety profiles and ASA risk distributions between Bupivacaine and Ropivacaine across various surgical procedures. The study emphasizes the importance of robust statistical analysis, such as p-values from chi-square tests, in discerning meaningful clinical differences in anesthesia practices across different patient populations. [7,9]

The study found no significant difference in mean height between patients using Bupivacaine and Ropivacaine ($p = 0.580$). Both groups have similar mean heights (159.57 cm for Bupivacaine and 158.87 cm for ropivacaine), consistent with recent literature on anesthesia and patient demographics. Studies have reported minimal to negligible differences between treatment groups, with no significant variations in height observed between Bupivacaine and Ropivacaine across diverse patient populations. These findings emphasize the reliability of the study's conclusion, as the slight difference in mean height is not indicative of a substantial physiological distinction between the two treatment groups. [4,5]

The study found no significant difference in mean weight between patients using Bupivacaine and Ropivacaine ($p = 0.089$). Although the Bupivacaine group had a slightly higher mean weight (56.67 kg) compared to the Ropivacaine group (52.97 kg), this difference is not significant. This is consistent with recent literature on anesthesia outcomes and patient demographics. Studies

have found minimal differences between treatment groups, with no significant disparities in weight observed across different surgical contexts. The study's slight difference in mean weight is not statistically significant at the 0.05 significance level, emphasizing the importance of robust statistical analysis for accurately assessing patient characteristics across different anesthesia regimens. [8,9]

The study compares the mean surgery durations between patients using Bupivacaine and Fentanyl versus Ropivacaine and Fentanyl. The results show no significant difference in the duration of surgery between the two groups. The overall mean duration for both groups combined is 107.59 minutes. This aligns with recent literature examining anesthesia duration across different local anesthetic combinations. Studies have shown similar outcomes in various surgical settings, with no significant variation in duration between the two agents when used with adjunctive Fentanyl. The slight variation observed in the study may be due to random sampling variability rather than a substantive difference in surgical efficiency or complexity.[4,5]

The study found that the mean onset time for sensory block in the BF group is 3.433 minutes, while in the RF group it is significantly longer at 6.783 minutes. This difference is less than 0.001. Studies have shown that the pharmacokinetic properties of these agents influence the onset times. For instance, a systematic review found faster sensory block onset times with Ropivacaine compared to Bupivacaine across various surgical procedures. Ropivacaine tends to achieve sensory blockade more rapidly when administered with Fentanyl.[8,9]

The study compared the mean time of onset of motor block at the T10 level between the BF (Bupivacaine with Fentanyl) and RF (Ropivacaine with Fentanyl) groups, finding significant differences. The BF group had a shorter onset time (mean: 4.77 minutes) compared to the RF group (mean: 7.53 minutes).

The study compares the mean duration of motor block at the T10 level between the BF (Bupivacaine with Fentanyl) and RF (Ropivacaine with Fentanyl) groups. The BF group showed a longer mean motor block duration of 301.900 minutes compared to the RF group, which had a mean duration of 263.800 minutes. This is supported by recent literature highlighting the differential effects of Bupivacaine and Ropivacaine in combination with Fentanyl on motor block duration. Bupivacaine provides a longer duration of both sensory and motor blocks, making it advantageous in surgical settings requiring prolonged anesthesia. Ropivacaine is preferred for shorter motor block durations due to its safer profile and fewer side effects. The higher variability in motor block duration observed in the RF group aligns with these studies.[10-13]

The study found significant differences in heart rates between patients receiving Bupivacaine with Fentanyl (BF) and those receiving Ropivacaine with Fentanyl (RF) at various time points. The BF group showed higher mean heart rates at 5 minutes, 15 minutes, 30 minutes, 60 minutes, and 120 minutes, while no significant differences were observed at 0 minutes, 10 minutes, 90 minutes, and 150 minutes. These findings align with recent literature on the cardiovascular effects of Bupivacaine and Ropivacaine when combined with Fentanyl. Bupivacaine is associated with higher heart rates in the early stages of administration due to its potent sympathetic nervous system blockade, while Ropivacaine is more stable and is often chosen for patients with critical hemodynamics. [14,15]

The study found no significant differences in oxygen saturation (SPO2) levels between patients receiving Bupivacaine and Ropivacaine at any time points. Both local anesthetics maintain similar SPO2 levels throughout the observation period, with no significant differences observed

in mean MAP levels. Both anesthetics are well-tolerated in terms of respiratory effects and have minimal impact on oxygen saturation when used within recommended dosage ranges and in appropriate patient populations. The addition of Fentanyl to local anesthetics like Bupivacaine and Ropivacaine does not significantly alter MAP, allowing for stable blood pressure maintenance during procedures. Both anesthetics are effective in maintaining stable SBP levels over the duration of surgery. The study also found significant differences in diastolic blood pressure (DBP) between patients receiving Bupivacaine and ropivacaine, with Bupivacaine initially elevating DBP more than Ropivacaine, but these differences diminish over time, leading to similar DBP levels between the two anesthetics in the longer term. [7,16]

The study compared the pain scores of patients receiving Bupivacaine and ropivacaine, revealing significant differences at multiple time points. Bupivacaine consistently provided lower VAS scores at 5 minutes, 10 minutes, 30 minutes, and 60 minutes post-administration, suggesting it may provide more effective pain relief in the early stages. However, no significant differences in VAS scores were found at later time points, suggesting a convergence in pain relief efficacy over time. Bupivacaine's potent blockade of nerve impulses and longer duration of action resulted in a faster onset of motor blockade compared to Ropivacaine. Both anesthetics eventually achieved similar levels of complete motor block by 30 minutes. The study also found no significant difference in rescue medication needed between Bupivacaine and Ropivacaine, suggesting that both anesthetic agents are generally effective in managing pain, with individual patient responses potentially varying based on specific clinical scenarios and procedural demands. [15,17]

CONCLUSIONS

The study compares Bupivacaine with Fentanyl (BF) and Ropivacaine with Fentanyl (RF) in terms of their effectiveness in pain relief. Bupivacaine has faster onset and longer duration of sensory and motor blocks, but also has higher rates of adverse effects like hypotension, shivering, and vomiting. Despite these differences, both anesthetics show similar results in SPO2, MAP, and hemodynamic stability, with no significant differences in rescue medication need. Age distribution, ASA status, and physical characteristics are comparable between the two groups, suggesting similar effectiveness.

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