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Original Article

Comparing the efficacy of Dexmedetomidine versus Fentanyl adjutants in lower limb orthopedic surgeries

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ABSTRACT

Objective: *to compare the effectiveness of dexmedetomidine versus fentanyl as adjuvants to hyperbaric bupivacaine surgeries of lower limb orthopedic.*

Methods: *This randomized controlled trial, approved by the committee of ethics Ghulam Muhammad Mahar Medical College, Sukkur, Pakistan, began patient enrollment in May 2023 and concluded in April 2024. Main outcomes of the study were rescue analgesia time and secondary outcomes include total consumption of nalbuphine in twenty-four hours and VAS score at 1, 6, 12 and 24 hours.*

Results: *Rescue analgesia time in dexmedetomidine was greater than fentanyl, 422.44±14.63 minutes and 311.39±7.86, respectively ($p<0.001$). The average total nalbuphine was lower in Group D as compared to the Group F, 7.88±1.84 mg/24 hours and 18.72±2.91 mg/24 hours, respectively ($p<0.001$). Whereas the frequency of rescue analgesia in Group D was lower than the Group F, 2.22±0.43 /24 hours and 3.72±0.46 /24 hours, respectively ($p<0.001$). Comparison of VAS score was significant at 6 and at 12 hours, ($p<0.001$).*

Conclusion: *The study findings indicate that intrathecal administration of dexmedetomidine is a promising alternative to fentanyl as an adjuvant in unilateral spinal anesthesia.*

Keywords: *Dexmedetomidine, Fentanyl, Orthopedic surgery, Rescue analgesia, Pain*

1. INTRODUCTION

Spinal anesthesia in low volume and doses of anesthetics is the best choice for lower limb surgeries[1]. It is associated with reduced incidence of hemodynamic instability and is more beneficial in old age patients, helps in fast recovery, and inhibits the unessential contralateral limb paralysis[2]. However, sensory and motor blockade and onset of action are slower as compared to bilateral spinal anesthesia[3].

Adjuvant medication with local anesthetic is trending now, as many drugs can improve the quality and effect of spinal anesthesia in adjuvant form4. Opioid drugs like sufantanil, morphine, and fentanyl can increase block duration and analgesia. α2 adrenergic agonists, including dexmedetomidine (DEX) and clonidine, can provide additional analgesia and sedation while reducing the required dose of local anesthetics[5]. Additionally, magnesium sulfate, midazolam, ketamine, and neostigmine, can also be used to enhance the effects of spinal anesthesia, contributing to better pain management and overall effectiveness of the anesthetic block[6].

Fentanyl, a highly potent synthetic opioid, stands out for its lipophilic nature, leading to a rapid onset and short half-life[7]. Despite its strength, fentanyl carries a minimal risk of causing respiratory depression. It is commonly used as an adjuvant in regional anesthesia due to its effectiveness[8]. When administered intravenously, fentanyl provides significant pain relief while maintaining the function of dorsal root axons and the integrity of somatosensory evoked potentials[9]. Moreover, fentanyl does not interfere with nociceptive afferent input from A and C fibers, ensuring targeted pain relief without compromising sensory pathways[10].

Dexmedetomidine (DEX) acts as an agonist for α2-adrenergic receptors in both the peripheral and central nervous systems[11]. When administered intrathecally, α2-adrenoceptor agonists like DEX produce analgesic effects primarily by inhibiting neurotransmitter release from C-fibers and causing hyperpolarization of postsynaptic neurons in the spinal cords dorsal horn[12]. Activation of these α2 receptors in the brain and spinal cord suppresses neuronal firing, leading to physiological responses such as hypotension, bradycardia, sedation, and enhanced analgesia[13].

This study offers a valuable contribution to optimizing unilateral spinal anesthesia for lower limb surgery by comparing the effects of adding DEX versus fentanyl to bupivacaine. These findings can help clinicians enhance postoperative pain management while reducing medication use and minimizing adverse effects.

2. METHODOLOGY

This randomized controlled trial, approved by the ethics committee Ghulam Muhammad Mahar Medical College, Sukkur, Pakistan, began patient enrollment in May 2023 and concluded in April 2024. The main outcomes of the study were rescue analgesia time and secondary outcomes including total consumption of nalbuphine in twenty-four hours and VAS score at 1, 6, 12, and 24 hours.

After taking consent patients a total of 26 patients having age 21-56 years, both gender, ASA status I, II, and planned for elective orthopedic lower limb surgery. Patients with BMI above 35 kg/m^2, heart failure, coagulation disorder, uncontrolled diabetes and hypertension, hypersensitivity to study drugs and who refuse to give consent were excluded.

Randomization of patients was done randomly in group D and group F. Patients in group D were given 10μg (0.5ml) dexmedetomidine as adjuvant in bupivacaine 2.5 ml, in other group F

fentanyl 25µg (0.5ml) in bupivacaine 2.5 ml. All medication was delivered by an anesthesiologist having 5 years' experience in anesthesia and is unknown to study drugs. SPSS version 27.1 was used for data analysis. Tests of significance were the t-test and chi-square test with a significant p-value of 0.05 or below.

3. RESULTS

A total of 36 patients, were included in our study. In both groups, equal numbers of patients were included 18 (50.0%) in each. The mean age, gender, BMI, ASA status, and surgical time were almost equal, in Group D and Group F, (p>0.050) (Table. 1).

The type of surgery was depicted in the figure. I. Pott`s fracture was the most common surgery type in Group D 5 (27.7%) whereas total knee replacement was the most common type of surgery in Group F 5 (27.7%), (p>0.050) (Figure. 1). The comparison of the requirement of analgesia is shown in the table. 2. The mean time to rescue analgesia in Group D was greater than the Group F, 422.44±14.63 minutes and 311.39±7.86, respectively (p<0.001). The average total nalbuphine was lower in Group D compared to Group F, 7.88±1.84 mg/24 hours and 18.72±2.91 mg/24 hours, respectively. (p<0.001). Whereas the frequency of rescue analgesia in Group D was lower than the Group F, 2.22±0.43 /24 hours and 3.72±0.46 /24 hours, respectively (p<0.001). (Table. 2). Comparison of VAS score was significant at 6 and at 12 hours, (p<0.001) (Table. 3).

Table-1: Basic characteristics of study

Variable	Group D	Group F	p-value
Age (years)	40.56±5.38	42.72±5.61	0.928
BMI (kg/m^2)	26.77±1.39	27.39±1.68	0.244
Gender			
Male	8 (44.4)	11 (61.1)	0.317
Female	10 (55.6)	7 (38.9)	
ASA			
I	14 (77.8)	15 (83.3)	0.674
II	4 (22.2)	3 (16.7)	
Duration of surgery (hours)	3.51±0.68	3.33±0.63	0.449

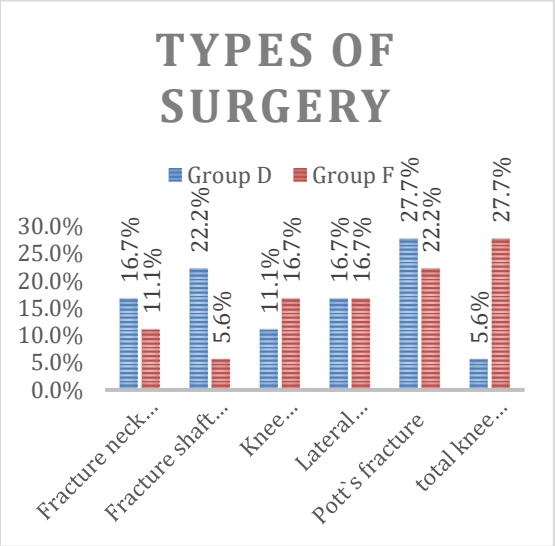
Table-2: Comparison of analgesic requirement

Requirement of analgesia	Group D	Group F	p-value
Time to rescue analgesia (minutes)	422.44±14.63	311.39±7.86	<0.001
Total Nalbuphine (mg) / 24 hours	7.88±1.84	18.72±2.91	<0.001
Frequency of rescue analgesia / 24 hours	2.22±0.43	3.72±0.46	<0.001
Mean ± S.D			

Table-3: Comparison of post operative VAS score

Post operative VAS score	Group D	Group F	p-value
At 1 hour	2.07±1.66	2.09±0.26	0.823
At 6 hours	4.78±0.36	3.39±0.74	<0.001
At 12 hours	3.13±0.41	4.48±1.05	<0.001
At 24 hours	3.35±0.63	3.75±0.64	0.069
Mean ± S.D			

Figure. 1



4. DISCUSSION

Agonists of alpha 2 adrenergic receptors or opioids are most commonly using adjuvants to intrathecal short-acting local anesthesia agents to increase spinal anesthesia duration and quality of anesthesia drug. Dexmedetomidine or Fentanyl is common α2 agonist's utilized agents[14]. In this research, it was reported that dexmedetomidine prolong the time to rescue analgesia significantly when compared with fentanyl. Furthermore, total nalbuphine dose and frequency for pain after surgery were also less significant in

the dexmedetomidine group as compared to fentanyl.

A study by Ghaly et al, [15] reported that patients who received dexmedetomidine had longer rescue analgesia time than fentanyl. Rescue analgesia duration was 295.93 ± 36.72 minutes in the fentanyl group and 409.63 ± 74.60 minutes in the dexmedetomidine group (P = 0.000).

These findings align with the outcomes observed in studies conducted by Gupta et al[16] and Rahimzadeh et al.,[17] and compared the use of 5 µg intrathecal dexmedetomidine and 25 µg fentanyl in addition to bupivacaine in patients undergoing lower abdominal surgeries and lower limb surgeries, respectively.

Rescue analgesia time was much prolonged in the dexmedetomidine group and the VAS score was also better as compared to fentanyl in the present study. This finding aligns with the results of Mostafa et al.,[18] who observed that VAS scores were notably lower in the group receiving intrathecal DEX 5 µg compared to the group receiving MgSo4 50mg for pain control after surgical intervention and to manage stress following cesarean delivery.

Yektaş et al[19] examined the impact of combining 4µg and 2µg of dexmedetomidine with hyperbaric intrathecal bupivacaine for cases of inguinal hernia repair under spinal anesthesia. They observed that the group receiving 4 µg experienced a longer mean time to the onset of pain. Similarly, Rai et al[20] reported that in orthopedic patients undergoing lower limb surgeries, the addition of 5 µg of DEX to spinal anesthesia was more effective in extending the time to rescue analgesia compared to 3 µg.

Another study by Taher-Baneh et al[21] reported that calf surgeries which were planned for elective procedure under spinal anesthesia required minimum amount of rescue analgesia for relief of pain for 24 hours in both dexmedetomidine and fentanyl group were same, as there was not minimum difference.

5. CONCLUSION

The study findings indicate that intrathecal administration of dexmedetomidine is a promising alternative to fentanyl as an adjuvant in unilateral spinal anesthesia. This approach provides superior postoperative analgesia and is associated with fewer side effects.

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