ORIGINAL RESEARCH

Comparison of the efficacy of dexmedetomidine and fentanyl as adjuvants to bupivacaine in arthroscopic knee surgeries

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ABSTRACT

Background: In arthroscopic knee surgery, post-operative pain management is a major concern as spinal anesthesia provides shorter duration of analgesia. Intrathecal opioids as adjuvants are a major help in prolonging the analgesic duration. **Aim**: To compare the efficacy of intrathecal 0.5% heavy bupivacaine with Dexmedetomidine 5 µg versus Fentanyl 25 µg in patients posted for elective arthroscopic knee surgeries under spinal anaesthesia. **Materials and methods**: The study was conducted on 80 patients with ASA I and II of either sex aged between 18-60 years. After receiving clearance from ethical committee, the patients were randomly allocated into 2 groups of 40 each. Both the groups received 0.5% hyperbaric bupivacaine 15mg, Group BD received 5µg of dexmedetomidine whereas Group BF received 25µg of fentanyl. **Results**: Group BD had showed considerably longer sensory and motor blockade time than Group BF. The mean time of sensory regression to S1 was 476±23 min in Group BD and 187±12 min in Group BF. There was no statistically significant difference between the two groups in the beginning of sensory and motor blockade. **Conclusions**: In arthroscopic knee surgeries, intrathecal dexmedetomidine is associated with extended motor and sensory block, hemodynamic stability, and lower demand for rescue analgesics in 24 hours when compared to fentanyl.

Key words: Dexmedetomidine, Fentanyl, Bupivacaine, Spinal anesthesia, Arthroscopic surgeries

INTRODUCTION

Spinal anesthesia is defined as "the regional anesthesia obtained by blocking nerves in subarachnoid space". Popularity, ease of use, quick action, reduced stress response to surgery, excellent post-operative analgesia, comparatively fewer side effects, and early patient discharge have made it the preferred option for many surgical operations.[1]

In recent years, adjuvants have been frequently used to complement local anesthetics in order to reduce the dose of local anesthetics, minimize adverse effects, and extend the duration of anesthesia.[2]

Intrathecal opioid injection, in conjunction with local anesthetics, improves intraoperative analgesia and will have longer-lasting postoperative pain relief. Anlipophilic opioid with a rapid onset of effect following intrathecal injection is fentanyl. When injected intrathecally, it does not diffuse to the fourth ventricle in adequate concentration to elicit delayed respiratory depression, it causes synergistic analgesia for somatic and visceral pain without affecting sympathetic block.[3]

Dexmedetomidine, a novel, highly selective 2-agonist, is being evaluated as a neuraxial adjuvant since it improves hemodynamic conditions and prolongs postoperative analgesia with relatively few adverse effects. [4-7].

According to prior studies, it is hypothesized that intrathecal 5 µg dexmedetomidine will have a greater postoperative analgesic effect when used under spinal anaesthesia , with less adverse outcomes. Hence this study was conducted to evaluate the safety profile of intrathecal dexmedetomidine and comparing its efficacy with intrathecal fentanyl.

MATERIALS AND METHODS

After obtaining written informed consent, this study was done on 80 patients aged between 18- 60 years with ASA grade I and II who were posted for elective arthroscopic knee surgeries under spinal anaesthesia after approval of clearance from ethical committee at Shri B.M. Patil medical college, Vijayapura over a period of one and half year.

Patients were randomly assigned into two groups of 40 each by a sealed envelope technique. Group BD received 0.5% hyperbaric bupivacaine 15mg +5µg Dexmedetomidine and Group BFreceived 0.5% hyperbaric bupivacaine 15mg + 25µg Fentanyl. Patient denial, Infection at the injection site, study drug related sensitivity, Coagulopathy or other bleeding disorders and Patients with heart blocks, peripheral neuropathy, cardiac, hepatic, pulmonary, renal failure were all excluded from the study.

During the preoperative visit, the patient's comprehensive medical history, general physical examination, and systemic examination were carried out. History of any significant medical illness was elicited. Airway, respiratory system, and cardiovascular system were assessed. Routine required investigations were performed. Written informed consent was taken for Anaesthesia as well as for taking part in the study and nil per oral status was confirmed. After shifting the patient to the operation theatre, standard intraoperative monitors like ECG, NIBP, SPO2 were connected and basal parameters were recorded. IV access with 20G cannula was obtained on the forearm and IVF (10-20ml/kg) were started before the subarachnoid block.

An experienced anesthesiologist who is also blinded for the study performed the lumbar puncture by midline approach and a Quincke spinal needle (25G) at the L3-L4 intervertebral space. After confirming CSF free flow, the study drug was administered. Patients were monitored intraoperatively for the changes in the hemodynamic parameters and documented throughout the procedure. Adverse events including hypotension were treated with mephentermine 6 mg incremental IV doses and IV fluids as needed. Hypotension is defined as a fall in systolic blood pressure by more than 20% from baseline. Atropine IV, 0.6 mg, was used to treat bradycardia, which is defined as a heart rate below 50 bpm. Side effects such as nausea, vomiting, shivering, pruritus, respiratory depression, drowsiness, and hypotension have been noted. The patient group was concealed from the surgeon, the patient, and the observing anesthesiologist. The maximum dermatome level of sensory blockade, the amount of time it took to achieve this level after the injection, the amount of time it took for S1 level sensory regression, time to urination, and the frequency of side effects were all noted. Pain has been evaluated by using visual analogue score. All the patients were given instructions about VAS and to site out the intensity of pain on the scale. Diclofenac was given intravenously as rescue analgesia when VAS was >4.

STATISTICAL ANALYSIS

A Microsoft Excel sheet was used to enter the data, and the statistical package for the social sciences (Version 17) was used to conduct the analysis. Drawings, MeanSD, counts, and percentages are used to display the results. Independent t test, Mann Whitney U test, Friedman test, and Dunn's post hoc test were used to compare the results. For all tests, significant was achieved at $p<0.05$.

RESULTS

In this study the demographic data between the two groups were comparable and statistically non significant (Table 1).

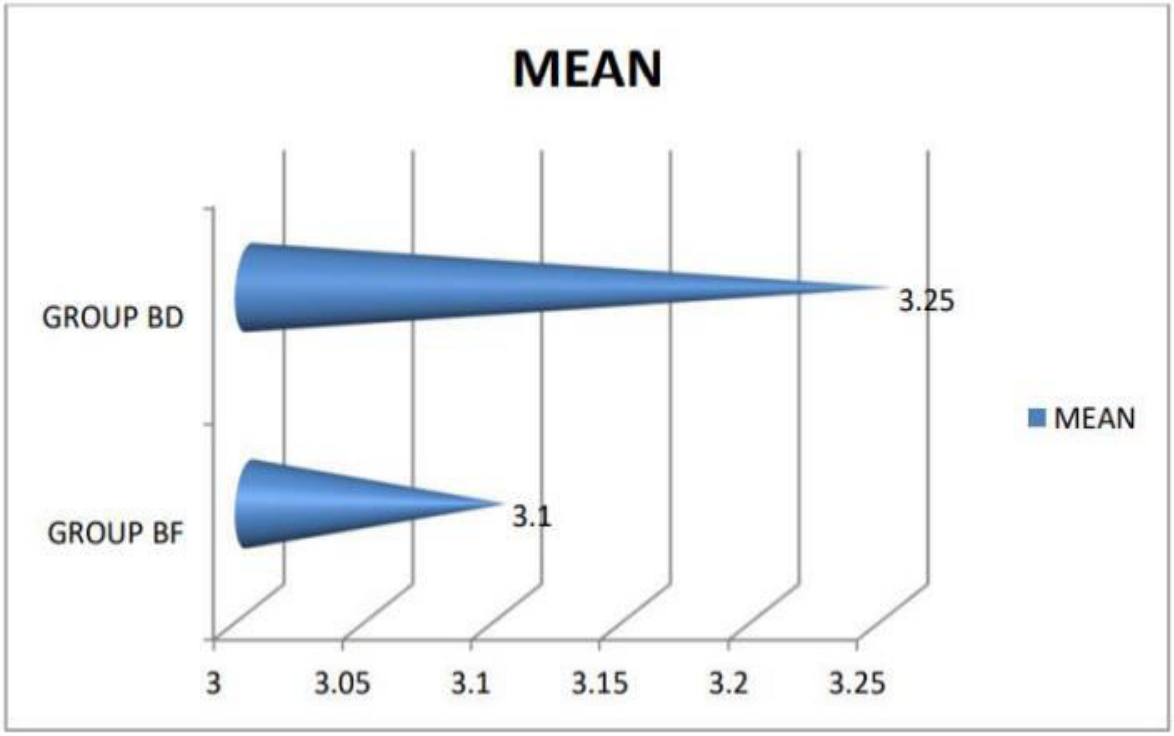
Table 1: Demographic data

Variables	Group I (BF)		Group II(BD)		Mann Whitney U test/t test	P VALUE	Remark
	Mean	SD	Mean	SD			
AGE	37.29(35)	11.85	37.37(35,5)	11.984	U=1752	P=0.928	NS
SEX Male/Female	41:19	-	41:19	-	-	-	-
HEIGHT	5.58(5.6)	0.28	5.50(5.5)	0.29	U=993	P=0.151	NS
WEIGHT	59.71(59)	7.9	59.82(60)	9.369	t=0.0633	P=0.949	NS
NS: Not Significant							

#Age in years, Height in inches, Weight in kilograms

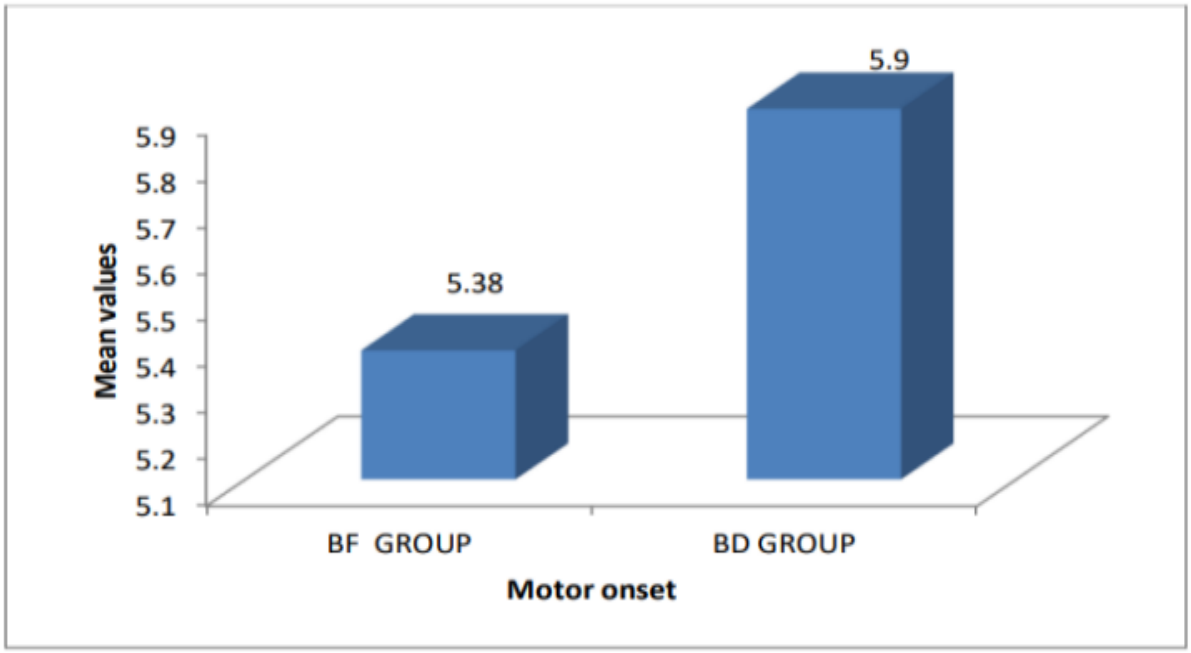
The mean time for onset of sensory block in group BF was 3.1±0.75 min and in group BD was 3.25±0.95 min. The onset of sensory block in both groups was statistically not significant (Figure 1).

Figure 1: TIMEOF ONSET OF SENSORY BLOCK



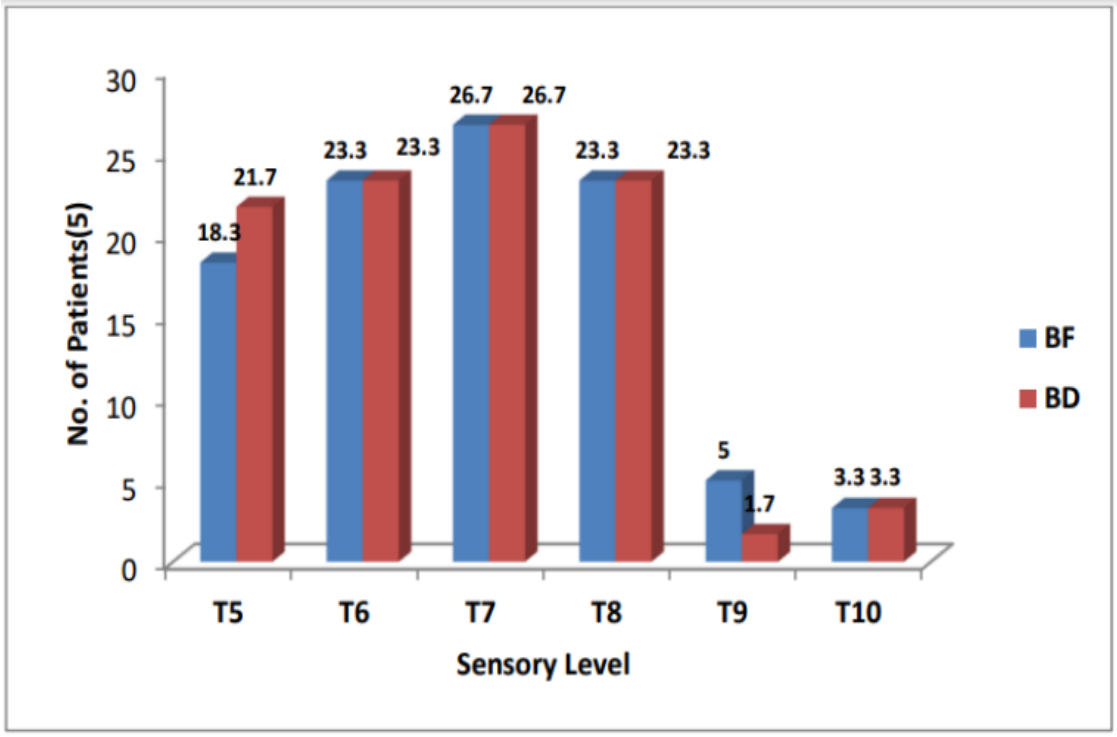
The mean time for onset of motor block in group BF was 5.38±1.1 min. and in group BD was 5.9±1.32 min. There was no statistically significant difference in two groups with regard to onset of motor block (Figure 2).

Figure 2: Time of onset of motor block



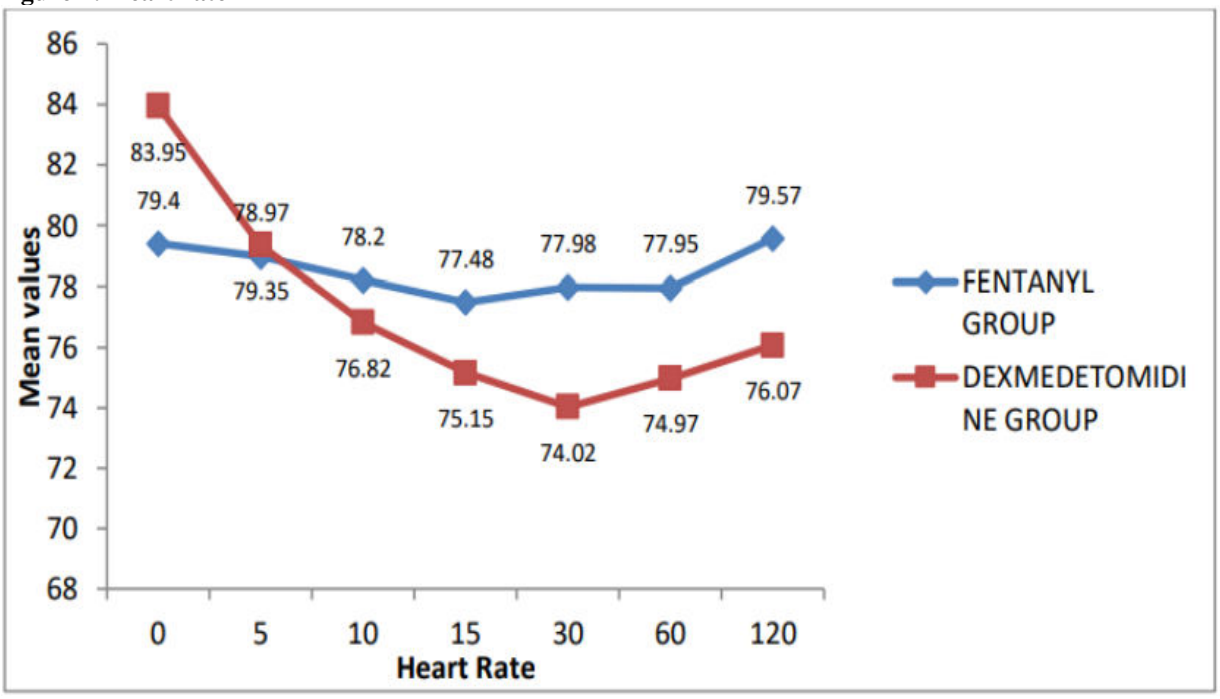
In our study the highest sensory level attained, patients in group BF 18.3% achieved T5 level, 23.3% achieved T6 level, 26.7% achieved T7level ,23.3% achieved T8 level, 5% achieved T9 level and 3.3% achieved T10 level. In group BD 21.7% achieved T5 level, 23.3% achieved T6 level, 26.7% achieved T7 level,23.3% achieved T8, 1.7% achieved T9 and 3.3% achieved T10. This implied that with regard to sensory level block there is no difference between the two groups (Figure 3).

Figure 3: Highest level of sensory block



At any interval the two groups did not differ statistically significant with respect to heart rate. In group BD five patients while in group BF two patients had bradycardia which was treated by 0.6mg Atropine successfully (Figure 4).

Figure 4: Heart rate

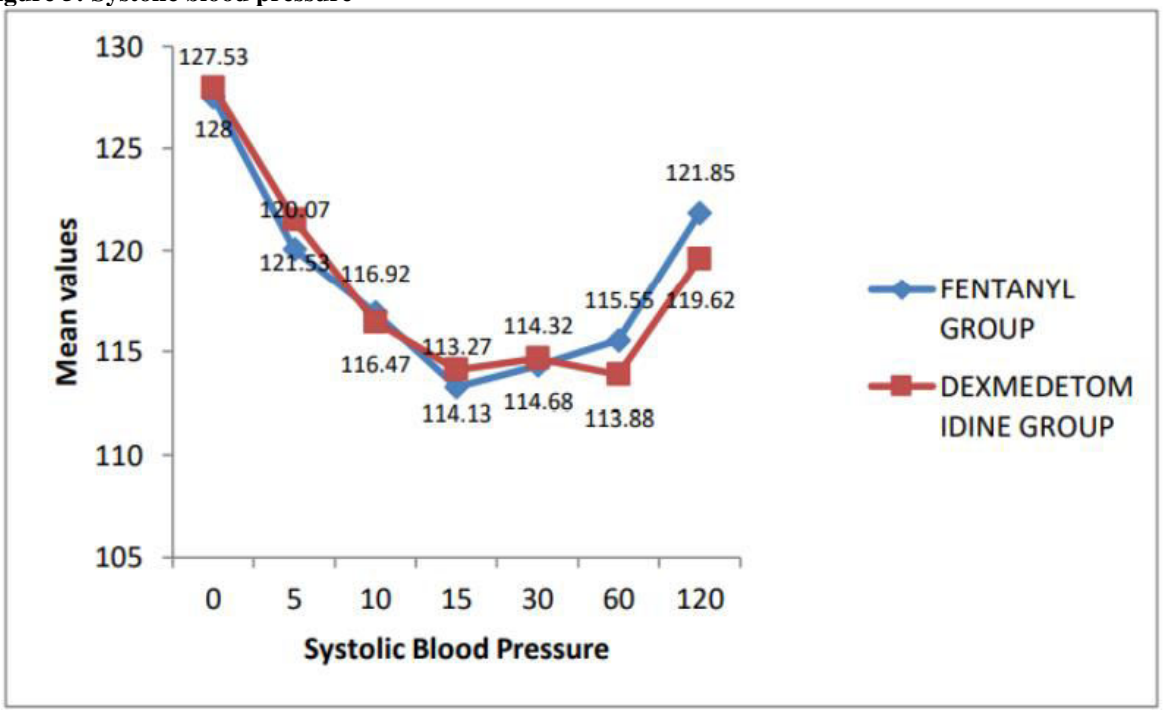


The mean SBP in group BF decreased from baseline 127mmHg to 120mmHg at 5 min,116mmHg at 10 min,113 mmHg at 15 min,114 mmHg at 30 min ,115mmHg at 60 min and which gradually increased to 121mmHg at the end of 120 min.

The mean SBP in group BD decreased from baseline 128 mmHg to 121 mmHg at 5 min, 116 mmHg at 10min, 114 mmHg at 15 min, 114 mmHg at 30 min, 113mmHg at 60 min and which gradually increased to 119 mmHg at the end of 120 min.

At any interval the two groups did not differ significantly with respect to SBP (Figure 5).

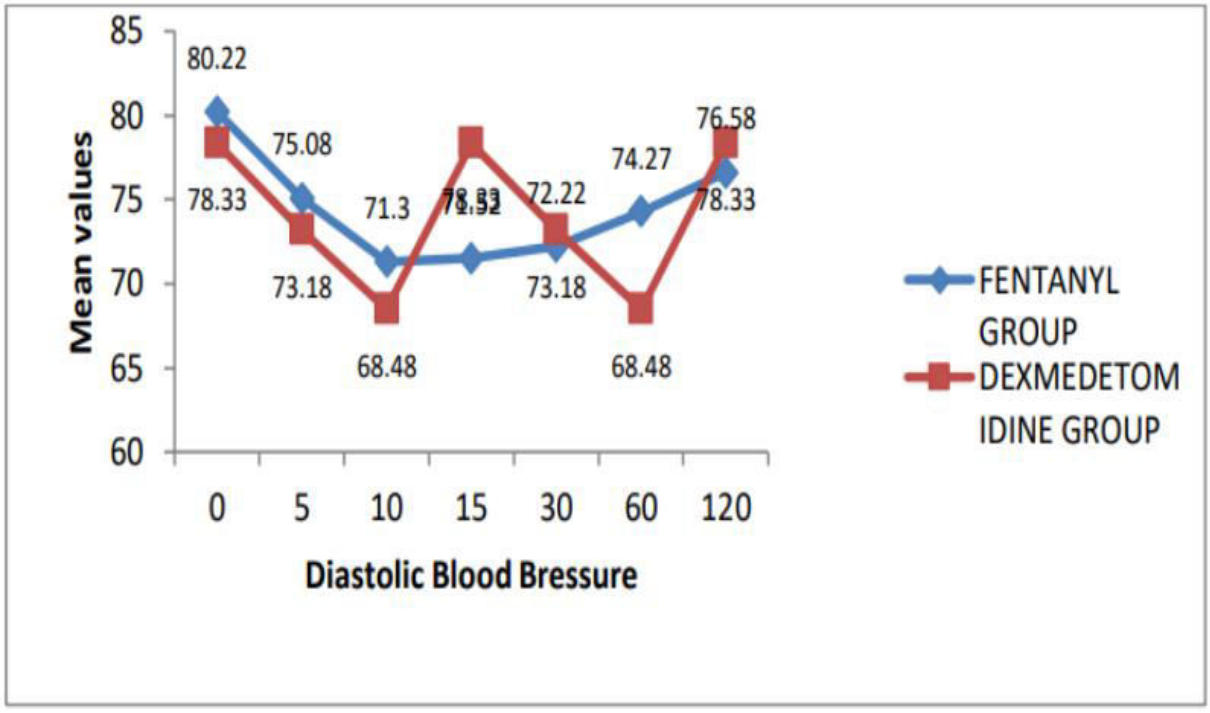
Figure 5: Systolic blood pressure



The mean baseline DBP in group BF was 80 mmHg which decreased to 75 mmHg at the end of 5 min, 71 mmHg at the end of 10 min,71 mmHg at the end of 15 min, after that BP started rising slowly from 72mmHg to 74 mmHg to 77mmHg at 30 min ,60 min and 120 min respectively.

The mean baseline DBP in group BD was 78 mmHg which decreased to 73 mmHg at the end of 5 min, 68 mmHg at the end of 10 min,67 mmHg at the end of 15 min, after that BP started rising slowly from 68mmHg to 70 mmHg to 73mmHg at 30 min ,60 min and 120 min respectively. At any interval the two groups did not differ significantly with respect to DBP(Figure 6).

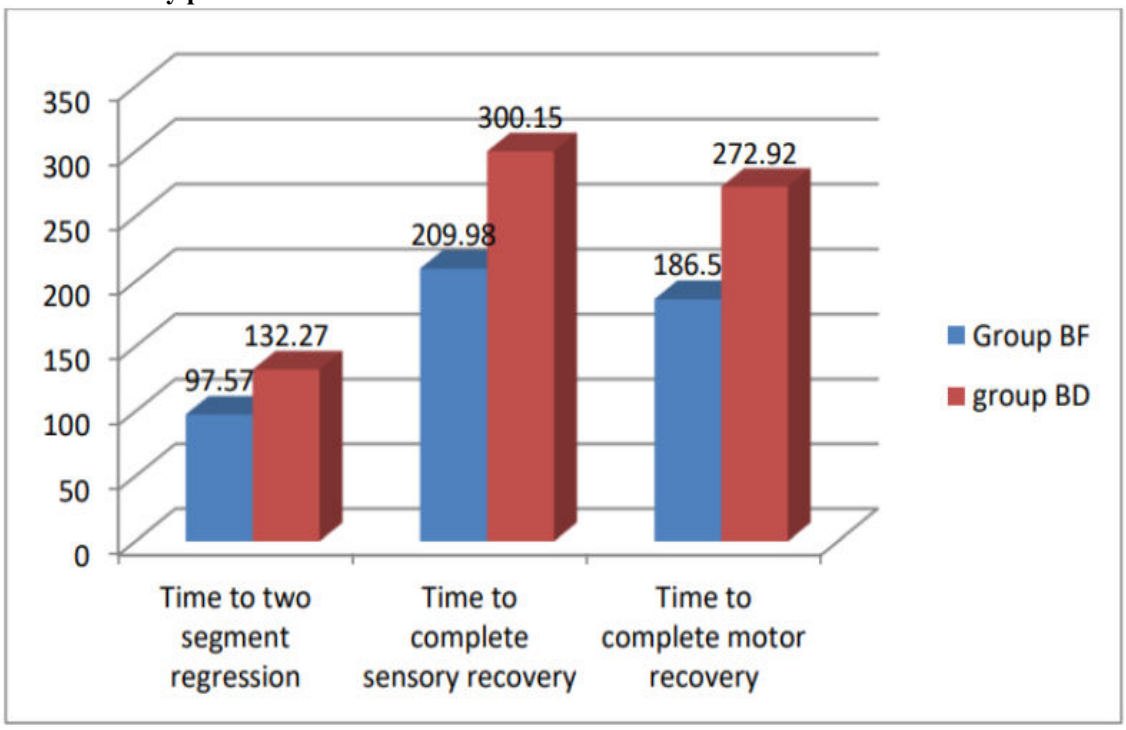
Figure 6: Diastolic blood pressure



The time for two segment regression was considerably slower in group BD with 132.27+9.5 min compared to group BF which was 97.57+8.8 min. The difference was statistically significant.

The mean duration of sensory block (time for complete sensory recovery) in group BF was 209.98+12.3 min and in group BD was 300.15+18.53 min. There was statistically significant difference in duration of sensory recovery. The mean duration of motor recovery in group BF was 186.5±13.22 min and in group BD was 272.92±23.32 min. There was highly significant difference between two groups regarding motor recovery (Figure 7).

Figure 7: Recovery parameters



The mean duration of complete analgesia in group BF 174.63±23.79 min and in group BD was 291.78±52.12min. There was statistically significant difference in both groups with regards to duration of complete analgesia. The mean duration of effective analgesia in group BF was 211.25±21.43 min. and in group BD was 351.3±36.3 min. There is highly significant difference in between two groups with regard to effective analgesia (Table 2).

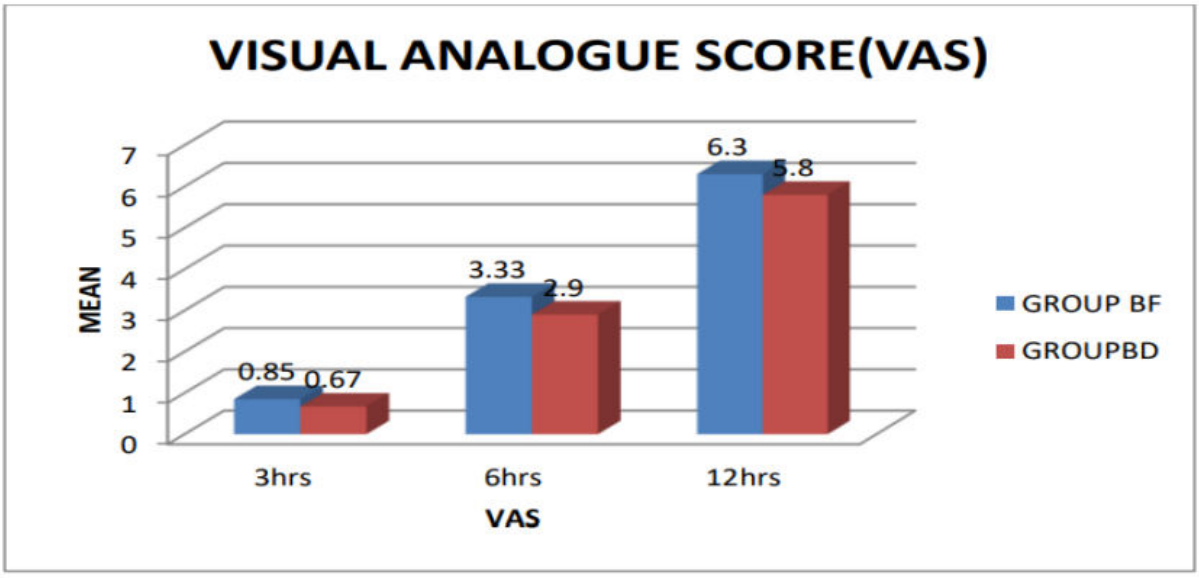
Table 2: Duration of analgesia

	Group BF	GROUP BD	Mann Whitney U test	P-value
Duration of complete analgesia(minutes)	174.63(170.0)± 23.79	291.78(264)± 52.12	0.500	P<0.001 HS
Duration of effective analgesia(minutes)	211.25(210.0)± 21.43	351.3(346)± 36.3	0.000	P<0.001 HS

HS-highly significant

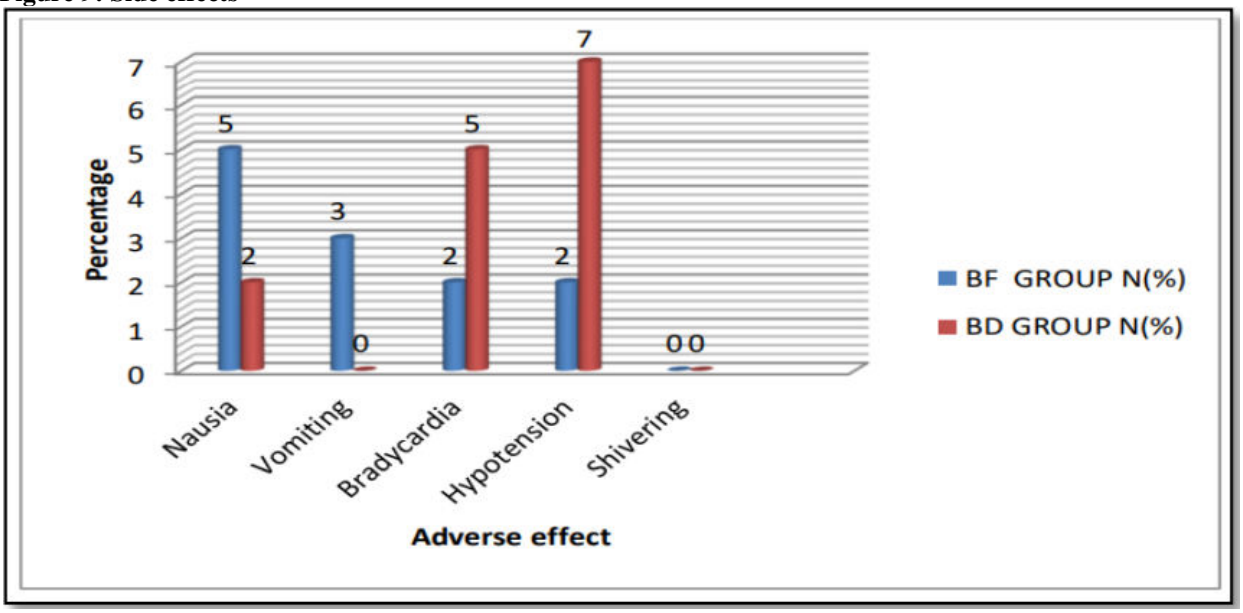
VAS at the end of 3hrs in group BF was 0.85±0.99 and group BD was 0.67±0.25.VAS at end of 6 hrs in group BF was3.33±1.05 and group BD was2.93±1.40.VAS at end of 12hrs in group BF was 6.3±0.83 and group BD was 5.8±0.88.VAS were statistically significant at the end of 3hrs and 12 hrs showing patient in group BD (lower VAS) had better pain relief than group BF in postoperative period (Figure 8).

Figure 8: Visual analogue score



In group BF 8.3% patients had nausea, 5% patients had vomiting, 3.33% patients had bradycardia, 3.3% patients had hypotension. In group BD 3.3% patients had nausea, 8.33% patients had bradycardia, 11.6% patients had hypotension (Figure 9).

Figure 9: Side effects



DISCUSSION

The ideal anaesthetic for lower limb procedures is spinal anaesthesia. It has the benefit of being affordable, simple to administer, quick to take effect, with very few side effects, and most importantly, patient remains aroused throughout the procedure. However, occasionally the foregoing advantages are outweighed by short duration and a painful postoperative period. Therefore, several adjuvants including morphine, buprenorphine and fentanyl, clonidine, and ketamine have been used in anaesthesia practice to extend the intraoperative analgesia into the postoperative period following spinal anaesthesia.[5]

Because of its sedative, analgesic, perioperative sympatholytic, anesthetic-sparing, and hemodynamic stabilising characteristics, alpha (α)-2-Adrenergic receptor (AR) agonists have drawn attention. Dexmedetomidine has all of these characteristics without respiratory depression, making it a useful and safe adjuvant in a variety of clinical applications. It is ahighly selective a2-AR agonist with a relatively high ratio of α2/ α 1-activity (1620:1 as compared to 220:1 for clonidine).By inhibiting the release of substance P and glutamate from primary afferent terminals and by hyperpolarizing spinal interneurons via G-protein-mediated activation of potassium channels, both α2-C and α2-AR activation in the superficial dorsal horn, especially lamina II, in the spinal cord, directly reduces pain transmission. Surgery's stress response can be reduced by using the sympatholytic effect of

post-synaptic activation of central 2-ARs, which causes bradycardia and hypotension.[4]

In clinical practice, the addition of an opioid to a local anaesthetic for spinal anaesthesia was first done in 1979. The quality of intraoperative analgesia is improved by the neuraxial injection of opioids in combination with local anaesthetics, which also prolongs the duration of postoperative pain relief.Fentanyl citrate, a μ1 and μ2 receptor agonist, is the most often used opioid in regional anaesthesia. Due to its high lipophilicity, the drug is highly effective. Its quick onset, short duration, and low cephalic spread make it the adjuvant of choice for spinal anaesthesia.

Al-Ghanem et al studied the effects of adding either 5 μg of dexmedetomidine or 25 μg of fentanyl intrathecally to 10 mg of isobaric bupivacaine during vaginal hysterectomy, came to the conclusion that 5 μg of dexmedetomidine produced a longer-lasting motor and sensory block than 25 μg of fentanyl.[5] In our study, we discovered longer durations of both sensory and motor blockade in the dexmedetomidine group, as well as improved hemodynamic condition and high patient satisfaction. In urological procedures, Al-Mustafa et al. investigated the effects of dexmedetomidine at doses of 5 and 10 μg in combination with bupivacaine. They discovered that dexmedetomidine increases the duration of spinal anaesthesia in a dose-dependent manner.[6]

Jitendra etal conducted a study on patients undergoing lower limb surgeries who were randomized to receive either 5 μg dexmedetomidine or 25 μg fentanyl intrathecally along with 12.5 mg Hyperbaric bupivacaine under subarachnoid block and they concluded that dexmedetomidine 5 μg added to intrathecal bupivacaine produced early-onset and prolonged block compared with fentanyl 25 μg. without any notable negative effects comparable to those in our study. They also noticed a gradual drop in blood pressure with dexmedetomidine but a sharp drop with fentanyl.[8]

Jakirhusen et al done a study Comparison of Dexmedetomidine and Fentanyl as an Adjuvant to Intrathecal Hyperbaric Bupivacaine in Elective Lower Limb Surgeries they concluded that dexmedetomidine 10 μg is a valuable adjuvant to bupivacaine compared to fentanyl 25μg which augments quality of spinal block and provides intraoperative sedation and hemodynamic stability. Where as in our study use of 5μg of dexmedetomidine avoided intraoperative sedation but having significant hemodynamic stability.[9]

A study by Poupak et al done on 90 patients undergoing lower limb elective surgeries who were randomly allocated to three groups,who received 2.5 ml hyperbaric bupivacaine 0.5% plus 5μg dexmedetomidine, 25μg fentanyl or 0.5 ml normal saline found that there was no significant difference between the groups regarding time to reach complete motor block, whereas time to reach the highest level of sensory block was shorter in group dexmedetomidine ($p = 0.03$). Unlike in our study there for no statistical significance seen in either motor or sensory blockade. [10]

In a study done by Mahmoud et al where comparison of two doses of intrathecal dexmedetomidine and fentanyl as adjuvant to hyperbaric bupivacaine in spinal anesthesia found that addition of intrathecal dexmedetomidine 3ug and 5ug or 25ug fentanyl to hyperbaric bupivacaine was associated with prolongation of both sensory and motor blockade, with better hemodynamics and minimal effect on blood glucose level, reduction of the pain scores postoperatively compared to bupivacaine alone. As such no statistically significant differences noted between 3 and 5 ug in their study[11].Whereas in our study only 5 ug of dexmedetomidine was evaluated for its efficacy and postoperative analgesia

A study by Sana et al conducted on Intrathecal bupivacaine along with fentanyl vs. dexmedetomidine for cesarean section found intrathecal dexmedetomidine 5 μg prolongs the duration of sensory block, with comparable hemodynamic changes and good postoperative analgesia, but prolonged motor block due to dexmedetomidine compared to intrathecal fentanyl 10 μg, which is not a desirable outcome particularly in surgeries with short duration like LSCS, which can increase discharge time from post anesthesia care unit (PACU) . Thus in our study arthroscopic surgeries were considered due to their prolonged duration of surgeries. [12]

CONCLUSION

The current clinical comparison study leads us to the conclusion that, when compared to 25μg Fentanyl, the addition of 5μg dexmedetomidine to hyperbaric Bupivacaine for spinal anaesthesia appears to be a novel alternative. It provides long lasting sensory and motor blockade, high-quality intraoperative and postoperative analgesia with limited side effects, and improved hemodynamic stability.

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