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Comparative Evaluation of Dexmedetomidine and Fentanyl as Adjuvants to Ropivacaine for Epidural Anesthesia in Lower Limb Orthopaedic Surgeries

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Abstract

Background: Epidural anesthesia is the most commonly used technique for providing not only peri-operative surgical anesthesia but also post-op analgesia in lower abdominal and limb surgeries. The addition of an adjuvant not only increases the effectiveness of a local anesthetic by prolonging and intensifying the sensory blockade but also causes reduction in dose of local anesthetic agent. In comparison to bupivacaine, ropivacaine is known to have lesser cardiotoxicity and motor blockade, with similar pain relief at equivalent analgesic doses. Fentanyl is partial agonist on μ opioid receptor. Mainly acting on the substantia gelatinosa of the dorsal horn of spinal cord. Dexmedetomidine is a selective a -2 agonist which provides sedation, anxiolysis, hypnosis, analgesia and sympatholysis. To evaluate dexmedetomidine and fentanyl as adjuvant for epidural local Anesthetics, for lower limb orthopedic surgeries in term of: Comparative evaluation of sensory and moter blockadge in relation of onset, duration and intensity Duration of postoperative analgesia Hemodynamics parameter.

Materials and Methods: 100 patients of either sex with ASA grade I and II, 21 to 50 yrs old, posted for elective lower limb orthopedic surgeries were randomly selected and divided into 2 groups of 50 each, Group RD- given 15 ml of 0.75% Ropivacaine along with Dexmedetomidine 1 μg/kg, Group RF- given 15 ml of 0.75% Ropivacaine along with fentanyl 1 μg/kg. After taking all aseptic precautions, 18 G epidural catheter was placed in space L3-L4 with the help of Touhy Epidural needle with use of LOR technique and fixed at 15 cm marking. Each patient was observed for, onset of sensory and Motor block, Height and Intensity of Motor Block Duration of post operative analgesia and Level of sedation.

Result: In comparison to addition of fentanyl as 1 microgram/kg (Group RF), addition of dexmedetomidine as 1 microgram/kg in 15 ml of 0.75 percent Ropivacaine (RD Group) for epidural anesthesia has early onset of sensory and motor block ($p < 0.001$), lesser time for achieving complete motor block ($P<0.001$) prolong duration of motor block and postoperative analgesia ($P<0.001$). Bradycardia and hypotension were found more in Group RD and nausea and vomiting were found more in Group RF but these findings in both the groups were statistically not significant. *Conclusion*: Addition of dexmedetomedine 1 μg/kg to ropivacaine, as comparison to addition of fentanyl, for epidural anesthesia has early onset of sensory and prolong duration of motor block and postoperative analgesia, without an increased incidence of side effects.

Keywords: Epidural set 18G; Ropivacain 0.75%; inj. Fentanyle; inj Dexmedetomedine.

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Introduction

Epidural anesthesia is the most commonly used technique for providing not only peri-operative surgical anesthesia but also post-op analgesia in lower abdominal and limb surgeries. ***Fidel Pages***[1] described a lumbar epidural in abdominal surgery in 1921. ***Achile Dogliotti***[2] described the loss of resistance technique to locate epidural space in 1931. The next important event in the history of regional anesthesia was the adaptation of Tuohy's catheter technique(1945) developed for continuous spinal anesthesia to lumbar epidural anesthesia by ***Curbello***[3] in 1949. The addition of an adjuvant not only increases the effectiveness of a local anesthetic by prolonging and intensifying the sensory blockade but also causes reduction in dose of local anesthetic agent. In comparison to bupivacaine, ropivacaine is known to have lesser cardiotoxicity and motor blockade, with similar pain relief at equivalent analgesic doses. Fentanyl is partial agonist on μ opioid receptor. Epidural fentanyl has been widely used as analgesic adjuvant mainly acting on the substantia gelatinosa of the dorsal horn of spinal cord. Dexmedetomidine is a selective *a* -2 agonist which provides sedation, anxiolysis, hypnosis, analgesia and sympatholysis.

Material and Methods

After prior permission of hospital ethical committee the present study was conducted in the department of Anesthesiology and critical care Medicine, MLB Medical College Jhansi on patients admitted for lower limb orthopaedic surgery.

Selection of Cases

100 Patients undergoing lower limb orthopaedic surgery of both genders, age ranging from 21 to 50 years and belonging to American Society Of Anesthesiologist (ASA) grade 1or 2 were screened and included in the study. A thorough preAnesthetic check up was done including the detailed history and physical examination. Airway examination was done In all patients.

Exclusion Criteria

- Patients refusal
- Diabetes mellitus
- Cardiac disease
- Hypertensive patients on β blockers
- Chronic obstructive respiratory disease
- Coagulation abnormalities
- Spinal deformities
- And patients allergic to amide type of local anesthetics were excluded from the study.

Informed and written consent was obtained from all patients. The patient was kept fasting as required for surgery. Procedure was explained to the patient. No medication preoperatively and divided into 2 groups of 50 each:

- Group RD- given 15 ml of 0.75% Ropivacaine along with Dexmedetomidine 1 μg/kg
- Group RF- given 15 ml of 0.75% Ropivacaine along with fentanyl 1 μg/kg

Drug preparation: Dexmedetomidine available as 100 mcg/ml so 0.5 ml was made to 2 ml by adding 1.5 ml NS in 2 ml syringe. Fentanyl 50 mcg/ml, 1 ml (50 mcg) made to 2 ml by adding 1.0 ml NS in 2 ml of syringe

Randomization 100 coded slip were prepared and placed in a plastic box and divided into two different groups and were kept inside a plastic box.

Multipara monitor- with HR, BP, SpO_2 and ECG recording

Epidural Tuohy Needle was used and it is 18G, 3 or 3.5 inch long (10 cm), blunt bevel with gentle curve of 15-30 degree at the tip.

Epidural catheter: Placing a catheter into the epidural space allows for delivery of study drug. Typically, a 19- or 20-gauge catheter is introduced through 18-gauge epidural needle. Catheter has marking up to 20 cm, every marking with 1 cm apart. Marking guides insertion length of epicat.

Lignocaine(2%): For skin infiltration at site of epidural needle insertion.

Dexmedetomidine: Available as 100 μg/ml in 0.5 ml, 1 ml and 2 ml ampoule.

Fentanyl: Available as 50 μg/ml in 2 ml ampoule.

Ropivacaine(0.75%): Available in 20 ml ampoule.

Anesthetic Technique

After shifting the patient to OT the procedure was explained to him again. Then multipara monitor was attached and reading of all vitals- HR, SBP, DBP, MAP, SpO_2 were marked as baseline values. Then 18G of IV canula was inserted into a peripheral vein and patient was hydrated with 10 ml/kg body weight of ringer's Lactate solution. The patient was placed in sitting position with straight leg on the OT table. The assistant maintain the patient in a vertical plain while flexing the patient neck and arms over the pillow to open up the lumber vertebral space. Under all Aseptic precautions, part was prepared, painted

& draped. At lumber space, L3-L4, 3 ml of 2% lignocaine is injected subcutaneously and a small skin wheal was formed. After interval of around 2 min, 18G epidural needle was taken & inserted through the skin, then LOR plastic syringe filled with 2 ml of air was attached. Then needle is further preceded through supraspinous ligament, pointing in a slightly cephaled direction then into the interspinous ligament, which is encountered at a depth of 2-3 cm. Then needle was advanced, millimeter by millimeter, with either continuous or rapidly repeating attempts. As the tips of needle just enter the epidural space there is a sudden loss of resistance and piston of syringe is easy pushed. Syringe was removed and catheter was introduced gently via the needle into the epidural space. The catheter has markings showing the distance from its tip and should be advanced to 15 cm through hub of the needle to ensure that sufficient length of the catheter has entered the epidural space. Then after needle was removed carefully. Epidural catheter was secured and patient placed in supine position. Test dose 3 ml of 0.75% ropivacaine with was administered into epidural space. After 15 min of test dose, the study drug was given via epidural catheter.

Result

A total 100 Patients undergoing lower limb orthopedic surgeries of both genders age ranging from 21 to 50 years belonging to American Society of Anesthesiologist (ASA) grade 1 or 2 were be screened out for the purpose of study

Each patient was observed for Demographic parameter, anthropometric parameter and duration of surgical time which was comparable in both group and statistically insignificant (P >0.05).

Difference in heart rate, systolic and diastolic blood pressure, mean arterial pressure, and SpO_2 of both groups was statistically insignificant (p value >0.05).

Table 1: Onset time of sensory block in min (at T10)

	Group RD	Group RF
Number of subjects	50	50
Minimum time (min)	8	10
Maximum time (min)	11	15
Mean (min)	9.22	11.30
Standard Deviation	0.86	1.12
Statistical significance	t= 11.62 p<0.001	

Table 1 shows that time to achieve sensory level at T10 was found to be significantly less (p<0.001) in Group RD (9.22±0.86 min) as compared to Group RF (11.30±1.12 min).

Table 2: Time of Onset of moter block (time taken to achieved Bromage motor scale 1)

	Group RD	Group RF
Number of subjects	50	50
Minimum time (min)	8	11
Maximum time (min)	12	15
Mean (min)	10.02	13.36
Standard Deviation	1.11	1.17
Statistical significance	P<0.001	

Tab 2 shows that significantly (p <0.001) early onset of motor block with Group RD was (10.02 min) as compared to Group RF (13.36 min).

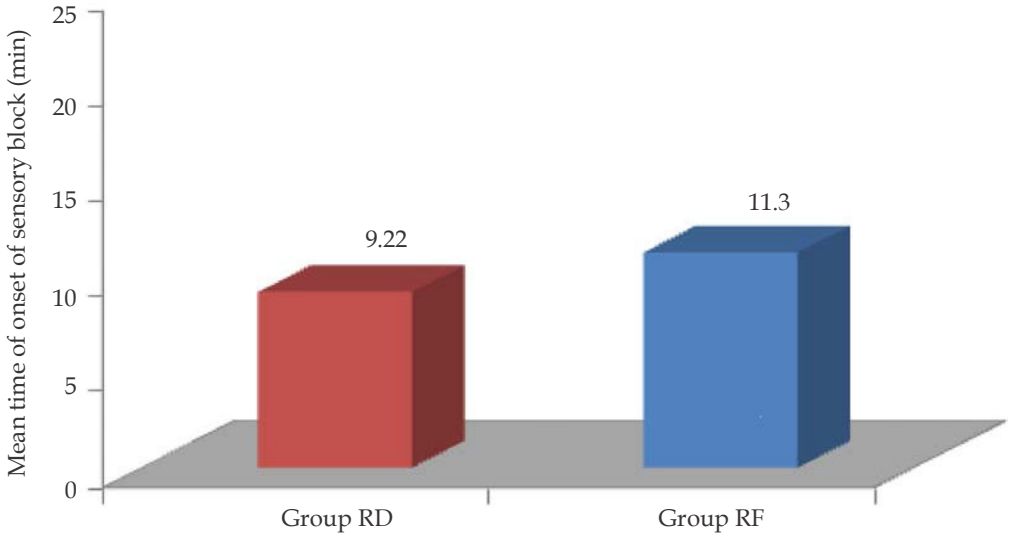


Fig. 1:

Table 3: Height of Block Achieved by Study Population

Sensory level	Group RD		Group RF	
	Number	Percent	Number	Percent
T4	6	12.0	–	0.00
T5	16	32.00	4	8.00
T6	24	48.00	33	66.00
T7	2	4.00	12	24.00
T8	2	4.00	1	2.00
Median level of block	T5		T6	

p value < 0.001

Table 3 shows that sensory level of T6, T7, and T8 was achieved significantly higher proportion ($p<0.001$) in subjects Group RF (92%) as compared to Group RD (56%) but block of T4 and T5 level was more higher proportion in group RD (46%) as compared to 8% in RF group. median level of block was T5 in RD as compared to T6 in Group RF.

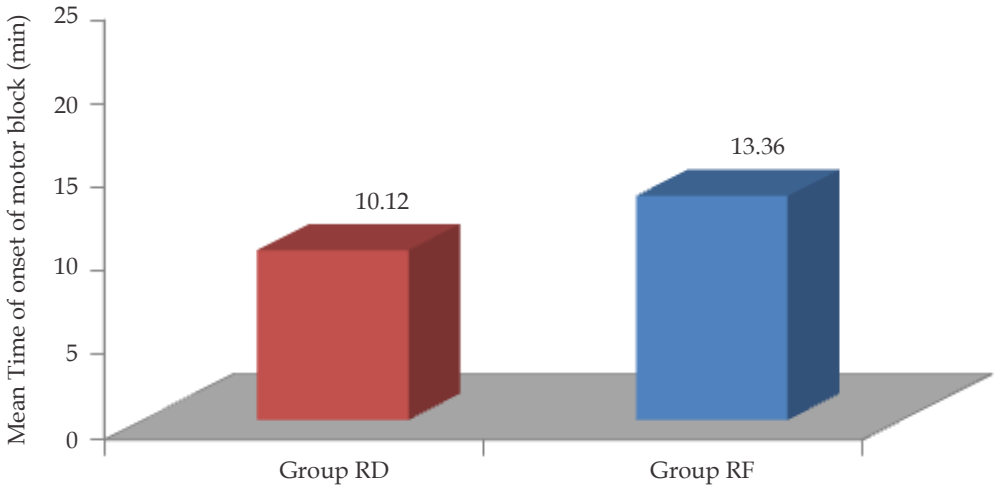


Fig. 2:

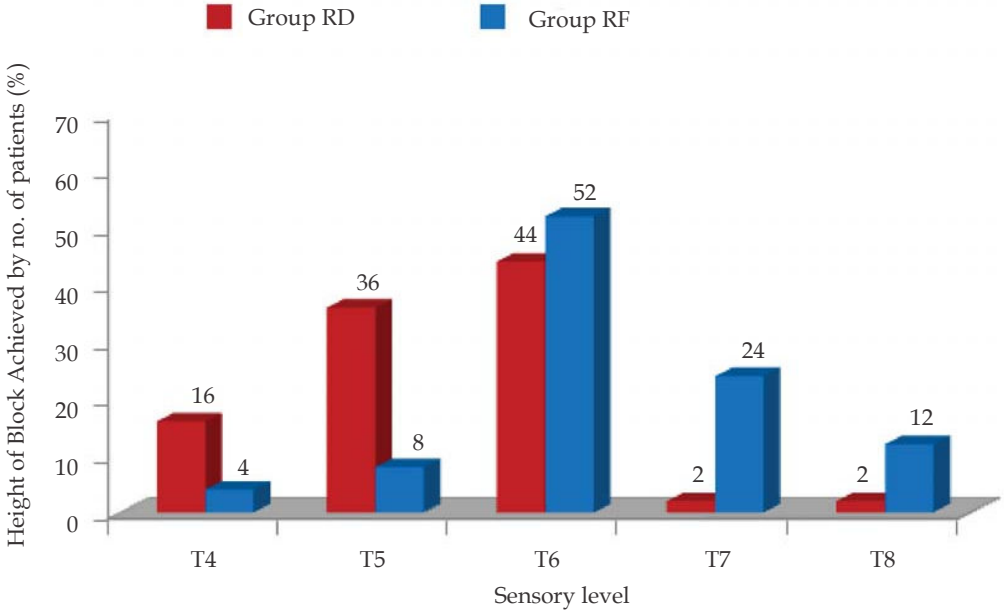


Fig. 3:

Table 4: Time to Achieve the Complete Motor Block (Min)

	Group RD	Group RF
Number of subjects	50	50
Minimum time (min)	14	20
Maximum time (min)	19	25
Mean (min)	17.9	24.00
Standard Deviation	1.82	0.94
Statistical significance	p<0.001	

Table 4 shows that time to achieve complete motor block in Group RD was 17.9+1.82 minutes and in Group RF it was found to be 24.00+0.94 minutes. Complete motor block was achieved in significantly lower (p <0.001) time by Group RD subjects as compared to Group RF subjects.

Table 5: Duration of motor block (min)

	Group RD	Group RF
Number of subjects	50	50
Minimum time (min)	210	175
Maximum time (min)	260	209
Mean (min)	231.88	189.7
Standard Deviation	10.46	9.24
Statistical significance	p value < 0.001	

Table 5 shows that duration of motor block in Group RD was 231.88±10.46 minutes and in Group RF it was found to be 189.7±9.24 minutes. Duration of motor block was significantly higher (p <0.001) in Group RD subjects as compared to Group RF subjects.

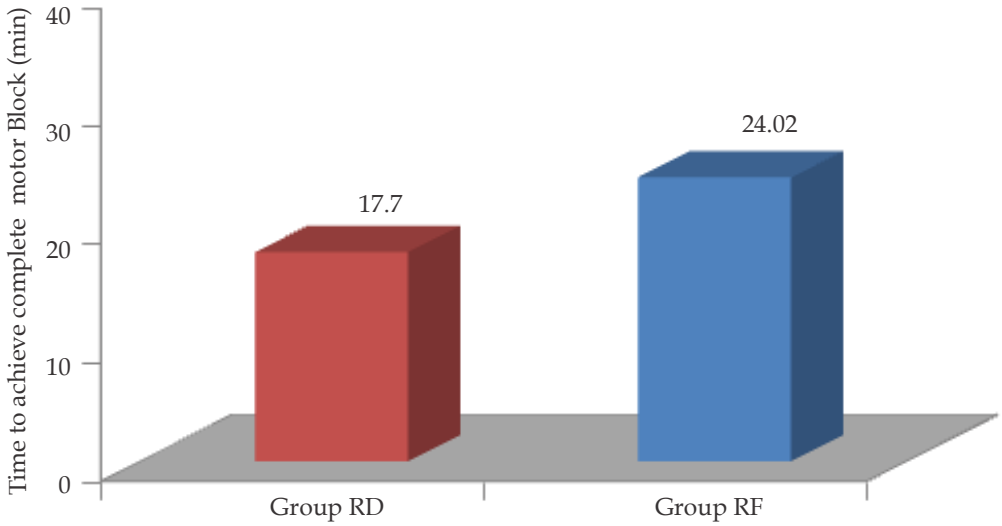


Fig. 4:

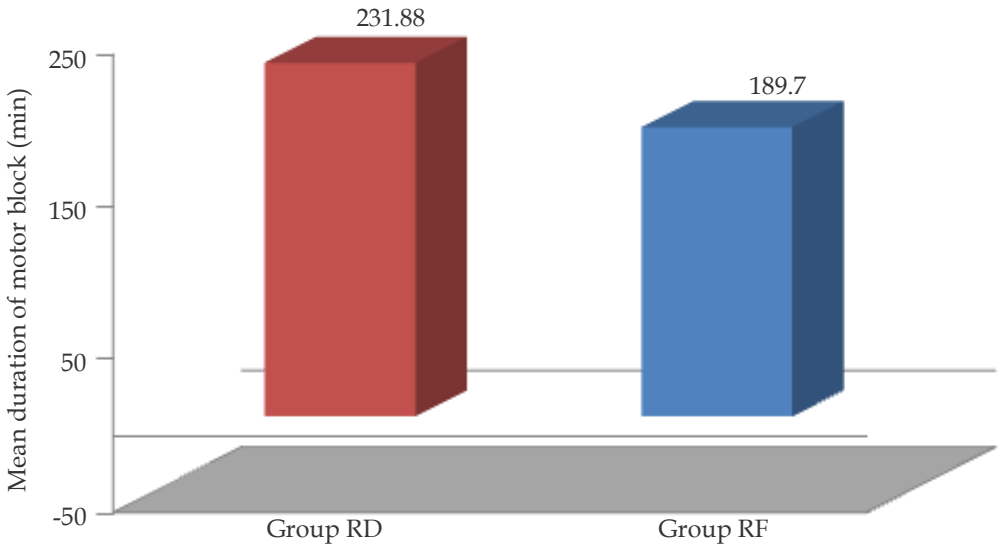


Fig. 5:

Table 6: Duration of Analgesia (minutes)

	Group RD	Group RF
Number of subjects	50	50
Minimum time (min)	340	240
Maximum time (min)	430	300
Mean (min)	382	272.50
Standard Deviation	20.84	20.14
Statistical significance	p<0.001	

Table 6 shows that duration of analgesia was significantly higher (p <0.001) in Group RD (382+20.84 minutes) as compared to Group RF (272.50+20.14 minutes).

Table 7: Side effects in Study Population

	Group RD		Group RF		Statistical significance
Side Effects	**No.**	**%**	**No.**	**%**	**p value**
Nausea/vomiting	8	16.00	11	22.00	0.181
Respiratory distress	0	0	0	0	–
Hypotension	4	8.0	3	6.0	0.695
Bradycardia	8	16	2	4.0	0.346
Urinary Retention	5	10.0	3	6.0	0.249

Table 7 shows that Nausea and vomiting was found to be in higher proportion of subjects from Group RF as compared to Group RD but this difference was statistically not significant (p >0.05). Hypotension, bradycardia were found in higher proportion of Group RD subjects as compared to Group RF, this was also statistically insignificant (p value >0.005). Urinary retention was also found in both group but which was insignificant.

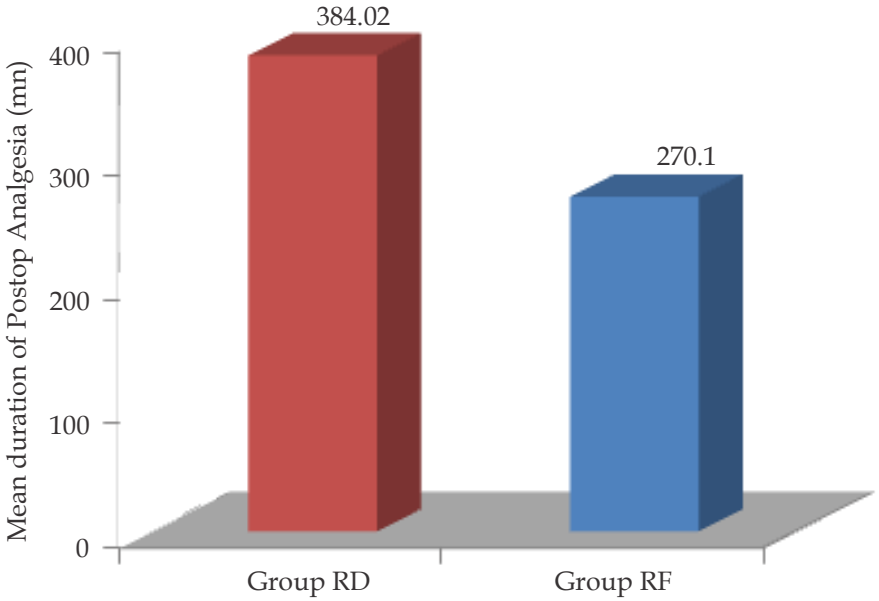


Fig. 6:

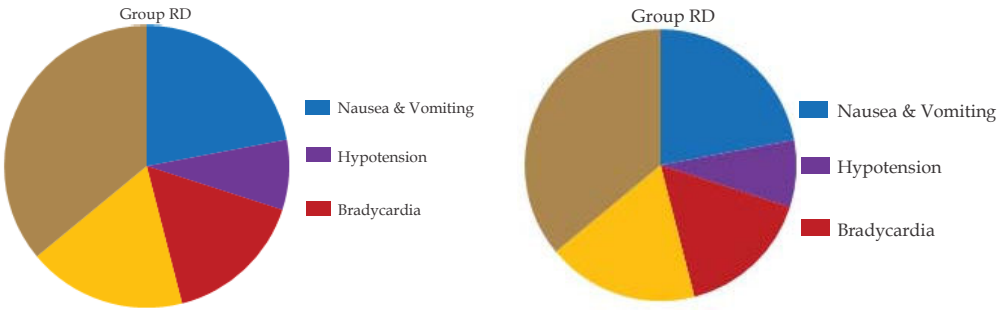
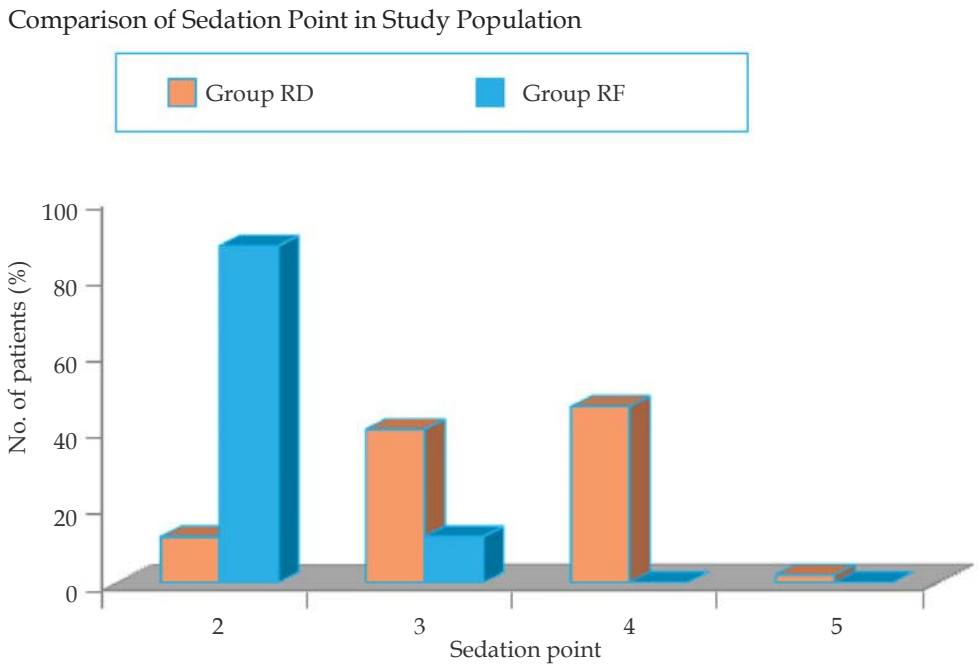


Fig. 7:



Sedation point 2 was found in significantly higher proportion of subjects from Group RF (80%) as compared to Group RD (16%). None of the subjects from Group RF reported Sedation point 4, 5.

In Group RD sedation score was 3&4 in most of case (84%) i.e. better sedation score was found in Group RD. Sedation score 5 was also non reported in group RD.

Discussion

The present study was designed to compare the effects of adding dexmedetomidine or Fentanyl as adjuvants to Ropivacaine in Epidural Anesthesia.

Anesthesiologist are specialized clinicians to treat pain by adopting various techniques and drugs. Pain is a very unpleasant and distressful condition to the patient. If not treated it may result into various physiological changes, including rise in heart rate, blood pressure, restricted physical activity and sleepless nights.

The use of lumbar epidural analgesia provides superior analgesia. It decreases the requirements of other Anesthetic agents intraoperativly and in post operative period it decreases the requirement of other systemic analgesic. Ropivacaine in comparison to bupivacaine, it has a wider margin of safety, less motor blockade, less cardiovascular or neurological toxicity.

Dexmedetomidine used in spinal, epidural, caudal, oral and intraarticular routes to provide analgesia was used in the current study. Maroof M et al.[4] (2004) were found that Dexmedetomidine has the following physiological properties: Sedation, analgesia, it reduces the stress response to the surgery by reducing plasma catecholamine concentration, and prevents shivering via α2 adrenoceptors in the central nervous system. Scheinin M, Pihlavisto et al.[5] (2000): The analgesic effect of the α2 agonists is a complex issue. They can induce analgesia by acting at three different sites: in the brain and brainstem, spinal cord and in peripheral tissues. α2-adrenergic and opioidergic systems have common effector mechanisms in the locus coeruleus, representing a supraspinal site of action. In the spinal cord, their analgesic effect is related to activation of the descending medullospinal noradrenergic pathways or to the reduction of spinal sympathetic outflow at presynaptic ganglionic sites. Moreover, there is also significant interaction between opioids and α2 agonists at the spinal cord level (Arian SR et al.[6] 1998).

The antihypertensive effect of dexmedetomidine results from stimulation of α2 inhibitory neurones in the medullary vasomotor center. Bradycardia is caused by an increase in vagal tone resulting from central stimulation of parasympathetic outflow, as well as a reduced sympathetic drive (Talke P, Chen R, et al. 2000).[7] Dexmedetomidine has unique sedative properties caused by hyperpolarization of excitable cells in the locus coeruleus (Berridge CW et al. 2003).[8] It produces a unique form of sedation, in which patients become responsive as well as

calm and cooperative when aroused, and then back to sleep when not stimulated. Confusion, cited as a common problem for other traditional sedatives. (Martin E, Ramsay G et al.).[9]

On analysis of the demographic profile the age and weight were comparable in both the groups. Age wise distribution of subjects in both the groups did not show any statistically significant difference (p=0.216). Weight of study subject in both the groups did not show any statistically significant difference (p=0.979). Duration of surgery was also comparable in both group.

Onset time of sensory block (at T10) was found to be significantly lower (p <0.001) in Group RD (9.22±0.86 min) as compared to Group RF (11.30±1.12 min). Sukhminder Jit Singh Bajwa et al.[10] Addition of dexmedetomidine to ropivacaine as an adjuvant resulted in an earlier onset (8.52±2.36 min) of sensory analgesia at T10 as compared to the addition of clonidine (9.72±3.44 min) comparison (P <0.05). Time of onset of motor block with Group RD was (10.02±1.02 min) as compared to fentanyl (13.36±1.17 min). Bhawna Rastogi, Kumkum Gupta et al.[11] (2013) found that epidural administration of 15 mL of 1% ropivacaine plus 100 µg fentanyl has onset times of motor block up to Bromage scale 1 and 2 were significantly more rapid in the Fentanyl group (11.9 +/- 4.6 and 24.4 +/- 5.9 min). Maximum height of sensory block is T6 (60%) as compared to Group RD (48%). More height of block was achieved in RD group, In Group RF median level of block was T6 as compared to T5 in Group RD.

Sukhminder Jit Singh Bajwa et al.[10] (2011): Dexmedetomidine with ropivacaine provided a higher dermatomal spread (mean level of block is T5 to T6). Sukhminder Jit Singh et al.[12] (Saudi J Anesth Year: 2011): used 0.75% Ropivacaine 15 ml + fentanyl (1 µg/kg) and of 0.75% Ropivacaine 15 ml +dexmedetomidine (1 µg/kg) found maximum sensory block achieved T4 to T6 in dexmedetomidine group as T5 to T7 in fentanyl group. Sarabjit Kaur et al.[13] (Saudi J Anesth Year: 2014): found that Epidural Dexmedetomidine (1 µg/kg) as an adjuvant to Ropivacaine 0.75% 15 ml is associated with T5 level of block. Time to Achieve the Complete Motor Block in Group RD was 17.9+1.82 minutes and in Group RF it was found to be 24.00+0.94 minutes. Complete motor block was achieved in significantly lower (p<0.001) time by Group RD subjects as compared to Group RF subjects. Manjunath Thimmappa et al.[14] (2014) were compare epidural ropivacaine 0.75% alone and Ropivacaine 0.75% with alpha 2 agonists and found that Mean time to complete motor blockade in Group Ropivacaine was 21.37±2.13 min, group RC was 16.47±1.38 min and in Group RD was 15.77±1.25 min.

Duration of analgesia was significantly higher (p <0.001) in Group RD (382.02+20.84 minutes) as compared to Group RF (272.50+20.18 minutes). Bang EC et al.[15] Onset of labor epidural analgesia with ropivacaine and a varying dose of fentanyl ware randomly assigned 0, 50, 75, or 100 µg with 0.2% ropivacaine 12 ml. The onset of analgesia (mean±SD) was shortened with an increasing dose of fentanyl (14.3±5.4, 14.2±6.5, 12.1±5.1, and 8.7±3.8 min with fentanyl 0, 50, 75, or 100 µg, respectively, P=0.001). The duration of analgesia was prolonged with an increasing dose of fentanyl (87.4±20.8, 112.3±19.5, 140.8±18.8, and 143.6±18.6 min with fentanyl 0, 50, 75, or 100 µg, respectively, P <0.001. The addition of increasing doses of fentanyl to 0.2% ropivacaine contributed to shortened onset as well as prolonged duration of labor epidural analgesia and improved patient satisfaction.

Sukhminder Jit Singh Bajwa et al.[12] (2011) also reveals statistically significant post-operative block characteristics among the two groups. The time for rescue analgesia was comparatively shorter (242.16±23.86) in the patients who were administered fentanyl as compared to dexmedetomidine group who experienced prolonged pain free period (366.62±24.42) (P=0.012). The superior block characteristics by the addition of dexmedetomidine were clearly evident from the lesser dose consumption (76.82±14.28) of ropivacaine for postoperative analgesia for the next 24 hours (P=0.026)

Salgado PF at et.[16] Epidural dexmedetomidine prolonged sensory and motor block duration time (p <0.05) and postoperative analgesia (p <0.05), and also resulted in a more intense motor block, l (p <0.05). Postoperative analgesia was prolonged significantly in RD group followed by the patient receiving fentanyl.

Nausea and vomiting was found to be in higher proportion of subjects from Group RF as compared to Group RD but this difference was statistically not significant (p >0.05).

None of the subjects from either of the groups had suffered with respiratory distress i.e. SpO_2 <90%. Hypotension, bradycardia and were found in higher proportion of Group RD subjects as compared to Group RF, but this difference was statistically non-significant. Dexmedetomidine produced significantly profound sedation (sedation score 4, 3 and 2 in 50%, 34% and 16% patients

respectively) as compared to mild sedation in Fentanyl group (sedation score 2 and 3 in 80% and 20% patients respectively).

Sedation score was highly significant with administration of dexmedetomidine.

Conclusions

Addition of dexmedetomedine 1 µg/kg to ropivacaine, as comparison to addition of fentanyl, for epidural anesthesia has early onset of sensory and motor block, prolong duration of motor block and postoperative analgesia, without an increased incidence of side effects. Therefore, it was concluded that dexmedetomidine is better as an adjuvant to ropivacaine than fentanyl for epidural anesthesia because of intense analgesia, better quality of motor block and prolong post op analgesia, along with higher sedation scores and insignificant side effects.

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