Original Research Article

A comparative evaluation of dexmedetomidine and fentanyl with ropivacaine (0.75%) for epidural anesthesia in lower limb orthopedic surgery

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ABSTRACT

Background: The aim of the study was to compare sensory and motor block characteristics, sedation score, post-operative analgesia and hemodynamic changes following epidural ropivacaine 15 ml (0.75%) supplemented with either dexmedetomidine (1 µg/kg) or fentanyl (1 µg/kg) in lower limb orthopedic surgery.
Methods: The study was conducted in 60 patients of either sex belonging to ASA status I , II or III, aged 20 to 60 years undergoing lower limb orthopedic surgeries. In this prospective, randomized controlled study patients were divided into two different groups. Group RD receiving dexmedetomidine 1 mcg/kg+15 ml ropivacaine (0.75%) and group RF receiving fentanyl 1 mcg/kg+15 ml ropivacaine (0.75%). Each group included 30 patients.
Results: The onset of sensory analgesia at shin of tibia was significantly early with dexmedetomidine (251.7±131.9 secs) as compared to fentanyl (503±63 secs) and similarly the onset of motor block was significantly early in group RD (533±239.6 secs) as compared to group RF (712.66±90.25 secs). Time for complete motor blockade was also significantly faster with group RD (57.1±5.1 mins) as compared to (61.5±3.2 mins) in group RF. The mean time for two segment regression was 274.3±43.6 mins in group RD, while 243.2±19.2 mins in group RF which was statistically significant (p<0.05). The decrease in heart rate, systolic, diastolic blood pressure and mean arterial blood pressure was significantly more in group RD as compared to RF.
Conclusions: Addition of dexmedetomidine to epidural ropivacaine produces rapid onset of sensory and motor blockade, prolonged duration of analgesia, with better hemodynamic stability as compared to fentanyl, hence being a useful alternative adjuvant.

Keywords: Epidural, Anesthesia, Dexmetedomidine, Ropivicaine, Fentanyl

INTRODUCTION

Epidural anesthesia is used for providing both intra-operative and post-operative anesthesia. In modern era lower limb orthopedic surgery, early post-operative mobilization and rehabilitation with minimal pain is desirable.[1-3] Epidural anesthesia is more versatile than spinal anesthesia as better hemodynamic stability and extended analgesia is offered with the former. In epidural anesthesia, in order to achieve desired effect large volume of LA (local anesthetic) is required, which increases possibility of LA toxicity. Ropivacaine has minimal cardiovascular and neurotoxicity and lesser propensity of motor block during post-operative epidural analgesia but requires higher doses than bupivacaine.[4-5] The addition of adjuvants like fentanyl or dexmedetomidine provide a dose sparing effect of LAs and accelerate the onset of

sensory blockade of epidural anesthesia and decrease the effective dose of local anesthestics.[6] Fentanyl acts as an agonist at μ-opioid receptor to enhance the analgesia but there is always a possibilities of increase incidence of pruritus, urinary retention, nausea, vomiting and respiratory depression.[7-8] Dexmedetomidine is α2 agonist, acts on pre and post-synaptic sympathetic nerve terminal and central nervous system to decrease sympathetic outflow and nor-epinephrine release causing a sedative, analgesic, sympatholytic and hemodynamic effect.[9-11] Motor blockade tends to be denser with dexmedetomidine and causes manageable hypotension and bradycardia but devoid of opioid related side-effects like respiratory depression, pruritus, nausea and vomiting.[12,13]

The objective of the study was to evaluate sensory and motor block characteristics, hemodynamic changes, sedation scoring and analgesic effect of epidurally administered fentanyl and dexmedetomidine when combined with ropivacaine (0.75%).

METHODS

This prospective randomized study was conducted in M. P. Shah medical college, Jamnagar, Gujarat over a period of one year (December 2014 to December 2015) after approval of institutional ethical committee and written informed consent was obtained from patients. 60 patients of either sex aged 20-60 years, ASA grade I, II or III having weighing 40-80 kgs were included in the study. Patients refusing consent, allergy to LAs, infection at puncture site, having coagulation abnormalities were excluded from the study. Preanesthetic examination of patients was done day prior to the surgery. In the operation room, standard monitoring such as EKG, pulse oximetry, non-invasive blood pressure was applied and baseline parameters were recorded. A peripheral intravenous line was secured with 18G cannula under all aseptic precautions and Ringer lactate was started and ondansetron 4 mg given intravenously (IV). In sitting position, epidural catheter was inserted through 18 gauge Tuohy needle into the epidural space at L2-3 inter-space using loss of resistance to air technique with all aseptic precautions. After securing epidural catheter on patient's back, a test dose (3 ml of 2% lignocaine with 1:200000 adrenaline) was given to exclude accidental intravascular or subarachnoid catheter position. Patients were divided into two groups using computer generated table according to drugs given epidurally, group RD receiving dexmedetomidine 1 mcg/kg+15 ml ropivacaine (0.75%) and group RF receiving fentanyl 1 mcg/kg+15 ml ropivacaine (0.75%). Sensory blockade was assessed by pin prick method using 26G hypodermic needle and graded accordingly (0=no sensation, 1=pin sensed as dull pressure, 2=sharp pain). Motor blockade was assessed by modified bromage scale (0=free movement, 1=knee flexion is decreased but full flexion of feet and ankles is present, 2=inability to raise leg or flex knees, 3=inability to raise legs, flex knee or ankle or move toes). Sensory

block characteristics studied were onset of sensory block time of onset at shin of tibia, sensory block at T10 level, time to two segment dermatomal regression. Motor block characteristics studied were onset of motor block (modified Bromage 1), complete motor block achieved (modified Bromage scale 3), time to first feeling of pain (total duration of analgesia). Ramsay sedation score was also noted every 30 minutes intraoperatively and 1 hour after the surgery (1=patient is anxious, agitated and restless, 2=cooperative, oriented and tranquil, 3=responds to command, 4=exhibits brisk response to light glabellar tap or loud auditory stimulus, 5=exhibits a sluggish response to light glabellar tap or loud auditory stimulus, 6=no response). When the anesthetic effects of epidural blockade were inadequate to perform surgery satisfactorily, spinal anesthesia was given using hyperbaric bupivacaine (0.5%) 2.6 ml and all these patients were excluded from the study. After giving epidural anesthesia, heart rate (HR), systolic, diastolic blood pressure (SBP, DBP) mean arterial pressure (MAP) and S_{PO2} were noted at 1, 5, 10, 15, 30, 60, 120, 180 minutes. Patients were also monitored for complications like nausea, vomiting, bradycardia, hypotension, shivering, respiratory depression, headache, dizziness, urinary retention during intraoperative period. Patients were shifted to recovery room at the end of surgery for monitoring and after complete reversal of epidural block, patients were shifted to ward. For quantification of pain, the conventional visual analog scale (VAS) score from 0 to 10 was used. When VAS ≥5, first dose of post-operative analgesia was given in the form of tramadol 1 mg/kg IV and bupivacaine 0.0625% (8 ml) in epidural catheter. Then subsequent doses of post-operative analgesia were given with same drugs when VAS ≥5 through epidural catheter. Epidural catheter was removed after 24 hours of insertion.

Bradycardia defined as heart rate less than 60 beats/min and was treated with atropine 0.6 mg IV. Hypotension defined as SBP <20% of baseline value or less than 90 mm of Hg was treated with additional Ringer's lactate solution IV or if needed injection ephedrine hydrochloride 5 mg was given IV titrated according to blood pressure.

Statistical analysis

Data were analysed using IBM® SPSS® statistics 20 statistical software package. Unpaired t test was used for quantitative data and chi-square test for qualitative data. P value <0.05 was taken significant. Sample size was calculated as 30 in each group and was calculated based on variation in data in literature taking 80% as power of study and 5% alpha error.

RESULTS

Patients were divided into two groups (30 patients in each group), group RD receiving dexmedetomidine 1

mcg/kg+15 ml ropivacaine (0.75%) and group RF receiving fentanyl 1 mcg/kg+15 ml ropivacaine (0.75%). Physical parameters like age, weight, sex distribution and the duration of surgery were comparable in both the groups and were statistically insignificant (p>0.05) (Table 1).

The onset of sensory blockade at shin of tibia in group RD was earlier (251.7±131.9 secs) as compared to group RF (503±63 secs) and the mean time of sensory block at T10 level in group RD was also earlier (499.3±168.6 secs) when compared with group RF (735±180.2 secs). The mean time for two segment regression from maximum sensory dermatomal level in group RD was 274.3±43.6 mins (more time) and 243.2±19.2 mins in group RF. All the parameters of sensory blockade, that is, onset (p<0.001), mean time of sensory block at T10 (p<0.001) and mean time for two segmant regression (p<0.05) were found statistically significant on comparing the two groups (Table 2).

Table 1: Physical parameters of the study groups and duration of surgery.

Particulars	Group RD Mean±SD	Group RF Mean±SD	P value
Age (in years)	35±9.8	40.5±14	>0.05
Weight (in kgs)	56.6±9.5	56±7.4	>0.05
Male (%)	86.7	73.3	>0.05
Female(%)	13.3	26.7	>0.05
Duration of surgery (in min)	109±33.3	95±28	>0.05

Table 2: Comparison of sensory blockade and motor blockade.

Particulars	Group RD (mean±SD)	Group RF (mean±SD)	P value
Time of onset of sensory blockade at shin of tibia (in seconds)	251.7±131.9	503±63	<0.001
Sensory block at T_{10} level (in seconds)	499.3±168.6	735±180.2	<0.001
Time to two segment dermatomal regression (in mins)	274.3±43.6	243.2±19.2	<0.05
Time of onset of motor blockade (modified Bromage 1 (in seconds)	533±239.6	712.7±90.3	<0.001
Time to complete motor blockade (in mins)	57.1±5.1	61.5±3.2	<0.05

Table 3: Comparison of pulse rate.

Pulse rate per minute	Group RF Mean±SD	Group RD Mean±SD	P value
Pre-induction	94.5±14.5	93.6±10.7	>0.05
1	94.4±14.2	93.5±10.6	>0.05
5	94.7±19.2	91.3±9.1	>0.05
10	92.6±12.1	88.0±8.6	>0.05
15	90.8±11.5	85.3±8.1	<0.05
30	87.0±10.0	79.5±7	<0.05
60	84.7±8.9	72.7±5.7	<0.05
120	83.1±9.7	71.2±6.7	<0.001
180	74±0	69.5±2.5	<0.05

Motor block onset was early in group RD (533±239.6 secs) and statistically significant (p<0.001) when compared to group RF (712.7±90.3 secs). Time of complete motor blockade was also faster in group RD which was 57.1±5.1 mins as compared to 61.5±3.2 mins in group RF and this was statistically significant (p<0.05) (Table 2).

Baseline hemodynamic parameters (HR, SBP, DBP, MAP) were comparable in both the groups (p>0.05).

In group RD, heart rate decreased from 93.6±10.7 to 69.5±2.5 beats per minute (bpm) while in group RF decrease in heart rate from 94.5±14.5 to 74±0 bpm (from baseline till 180 min post epidural injection of drugs).

This decrease in HR was statistically significant after 15 mins of epidural injection to up to completion of surgery between the two groups (p<0.05) (Table 3).

Fall in MAP was observed from baseline 92.3±5.6 mmHg to 80.7±1.1 mmHg in group RD and 92.8±5.7 mmHg to 84±0 mmHg in group RF till 180 mins post epidural injection and it was statistically significant after 15 mins in group RD as compared to group RF (p<0.05) (Table 4). The difference in total duration of analgesia was significant between the two groups (356.5±41.8 mins in group RD and 289.5±13.9 mins in group RF) in dexmedetomidine group, patients first felt pain postoperatively at a later duration when compared to patients receiving fentanyl.

In our study we observed that 38% and 42% of patients exhibited grade II and grade III sedation score respectively in group RD as compared to 16% and 2% of patients in the RF group. These sedation scores were statistically significant (p<0.001). Only 12% of the patients in the RD group had sedation scores of I (wide and awake) as compared to 82% in RF group which was statistically significant (p<0.001) (Table 5).

Table 4: Comparison of mean arterial blood pressure.

Mean arterial pressure (mmHg) (in mins)	Group RF	Group RD	P value
	Mean±SD	Mean±SD	
Pre-induction	92.8±5.8	92.3±5.5	>0.05
1	92.6±5.8	91.7±5.6	>0.05
5	91.0±5.3	90.5±5.9	>0.05
10	89.7±5.0	88.8±5.5	>0.05
15	90.8±4.3	84.6±3.9	<0.001
30	90.0±4.0	83.1±2.8	<0.001
60	88.8±3.4	81.7±8.3	<0.001
120	87.2±4.1	80.4±1.7	<0.001
180	84±0	80.7±1.1	<0.05

Table 5: Comparison of intraoperative sedative scores in patients of group RD and group RF.

Sedation scores during surgery	Group RD; number of patients (%)	Group RF; number of patients (%)	P value
1	4 (12)	24 (82)	<0.001
2	11 (38)	5 (16)	<0.001
3	13 (42)	1 (2)	<0.001
4	2 (8)	0	
5, 6	0	0	

DISCUSSION

Epidural analgesia, especially when LA is combined with adjuvants like systemic opioids provides a superior pain relief and early mobilization.[1] Epidural block also permits analgesic dosing through the catheter for post-operative pain management. It avoids invasive dural penetration and spinal hypotension. Epidural local anesthetics and opioids synergism is well established, but evidence regarding the combination of LA with dexmedetomidine through epidural route is less in literature.[14]

Conducting surgeries under epidural anesthesia (either as the sole anesthetic or in combination with general anesthesia) may reduce perioperative morbidity and mortality compared with general anesthesia alone.[15] Ropivacaine has an epidural potency similar to bupivacaine but has improved cardiotoxicity profile and reduced motor block at doses which provide analgesia. The addition of adjuvants like opioids or α2 agonists provide dose sparing effects of LAs and would accelerate the onset of sensory blockade of epidural anesthesia and decrease the effective dose of LA. Sedation, stable hemodynamic and an ability to provide prolonged postoperative analgesia are the main desirable qualities of an epidural adjuvants.[16]

The present study was undertaken to evaluate the effect of dexmedetomidine and fentanyl as an adjuvant to epidural ropivacaine in patients undergoing elective lower limb orthopedic surgeries.

In our study, the mean time of onset of sensory block, mean time of sensory block to reach T10 level, onset of motor block was earlier in group RD as compared to group RF. The time for two segment regression, time to achieve complete block (modified Bromage 3) and duration of analgesia was longer in dexmedetomidine group. All these parameters were found statistically significant on comparing the two groups and these

finding were supported by various previous investigators with similar results.[17]

On comparing the hemodynamics, we found that more decrease in HR, SBP, DBP, MAP occurred in group RD which was statistically significant after 15 minutes of the epidural administration of the drug when compared to group RF.

The more decrease in the heart rate caused by dexmedetomidine, α-2 agonists is due to their central action to decrease the sympathetic outflow and norepinephrine release.[18] In our study, despite more decrease in HR and MAP in group RD, no incidence of bradycardia and hypotension was noted as observed in another study conducted by Soliman and Eltaweel.[19] A study conducted by Eskandar et al found that the HR decreased significantly, but the decrease in MAP was not significant in dexmedetomidine group.[20] In contrast to our study, Bajwa et al found no significant changes in the HR and BP on using dexmedetomidine as an adjuvant to ropivacaine compared to the control group.[18]

We observed that 38% and 42% of patients exhibited sedation score 1 and 2 as compared to 16% and 2% of patients in the RF group, respectively. These sedation scores were statistically significant on comparison (p<0.001). Only 12% of the patients in the RD group had sedation scores of 3 (wide and awake) as compared to 82% in RF group which was a highly significant statistical entity (Table 5). This was supported by Salgado et al who found that patients were more sedated with lower bispectral values in dexmedetomidine group.[21]

The limitations of this study are the relatively small number of patients that were included and the exact dose equivalence of dexmedetomidine and fentanyl that was used in epidural anesthesia.

CONCLUSION

Addition of dexmedetomidine to epidural ropivacaine produces rapid onset of sensory and motor blockade, prolonged duration of analgesia, with better hemodynamic stability as compared to fentanyl. We concluded that dexmedetomidine may be a useful and better alternative to fentanyl as an adjuvant to epidural ropivacaine because of its sympatholytic, analgesic, sedative and better hemodynamic stability.

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