 DOI: 10.18231/2394-4994.2016.0018

Comparison of intrathecal dexmedetomidine and fentanyl on quality of subarachnoid block in patients undergoing lower abdominal surgeries: a randomized double blinded study

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Abstract

Background: Local anaesthetics have relatively short duration of action. Various adjuvants have been used to increase duration of block under subarachnoid block. The duration of surgical intervention varies from patient to patient and are associated with visceral manipulation causing somatic and visceral pain. Hence an attempt is made in this study to increase duration of block and also to cover postoperative analgesia by adding adjuvants to intrathecal bupivacaine. Alpha-2 adrenoceptor agonists act on dorsal horn of spinal cord and in combination with local anaesthetics increase the duration of sensory and motor block following subarachnoid block and also intrathecal opioids are known to prolong duration of subarachnoid block. The present study was done to compare the effects of intrathecal dexmedetomidine and fentanyl on duration of sensory and motor block and time for first post-operative analgesia.

Methodology: Sixty patients of ASA I, II scheduled for lower abdominal surgeries under subarachnoid block were allocated to receive either 10mg bupivacaine plus 5mcg dexmedetomidine [Group D, n=30] or 10mg bupivacaine plus 25mcg fentanyl [Group F, n=30] by double blinded study after giving informed written consent. Level of block achieved, duration of sensory and motor block and time for first post operative analgesic was noted. Any >20% fall in BP was treated with ephedrine and heart rate <60bpm was treated with atropine.

Results: The study showed that Group D patients had prolonged duration of motor block for upto six hours and required analgesic after nine hours following subarachnoid block where as in Group F patients duration of motor block was three hours and required analgesic at three and half hour with statistical significance [$p<0.05$].

Conclusion: Dexmedetomidine when used intrathecally is a better alternative than intrathecal fentanyl for prolonging the duration of sensory and motor block as well as prolonging time for first post operative analgesic.

Keywords: Dexmedetomidine, Fentanyl, Subarachnoid block, Analgesia

Introduction

Spinal anaesthesia is one of the most effective and popularly used technique in anaesthesia as it is safe, needs less sophisticated anaesthetic equipments[(1)] and also because of its profound analgesia and muscle relaxation.[(1)]

Local anaesthetics have relatively short duration of action. Many adjuvants have gained popularity in prolonging sensory, motor block during subarachnoid block as well as duration of analgesia in the postoperative period when used with hyperbaric bupivacaine. These adjuvants include fentanyl, midazolam, clonidine, intrathecal alpha-2 agonists.[(2)] However intrathecal fentanyl is associated with various side effects like pruritis, respiratory depression nausea vomiting[(3)] and intrathecal clonidine is known to cause hypotension, bradycardia, arrhythmias, drowsiness.[(4)]

Dexmedetomidine is a highly selective alpha 2 agonist with distribution half life of six min and elimination half-life of two hours. It has a very safe therapeutic window with respect to respiratory depression.[(5)] Dexmedetomedine has been recently evaluated as an adjuvant to intrathecal local anaesthesia.[(6)] It's affinity to α2 receptors is ten times of clonidine.[(7)] Dexmedetomidine when used with bupivacaine intrathecally onset of block is fast and regression time of block is slow.[(8)] Dexmedetomidine is full agonist to alpha 2 receptors (1620:1, alpha 2:alpha 1) as compared to Clonidine which is considered as a partial agonist, it is also shorter acting, and has reversal drug for its sedative effect, atipamezone which make it suitable during whole preoperative period as a adjuvant, post-operative sedative and analgesic.[(9,10)]

Intrathecal and epidural characteristics of Dexmedetomidine were studied in animals.[(11)] However there is little literature available about the use of intrathecal dexmedetomidine with bupivacaine in humans. Kanazi et al[(12)] showed that 3µg dexmedetomidine and 30µg clonidine are equipotent intrathecally when added to bupivacaine in patients undergoing urology procedures.

Many studies have shown the efficacy of dexmedetomidine in epidural space without serious side effects,[(13)] however there are few studies comparing it with intrathecal fentanyl. The present study was conducted to know the effect of intrathecal dexmedetomidine with intrathecal fentanyl with respect to duration of motor and sensory block and time to request for first postoperative analgesia.

Methodology

This prospective randomized double blinded study was done at Department of Anaesthesia, KLE's Jawaharlal Nehru Medical College, Belgaum from June 2010 to May 2011. After obtaining Ethical Clearance from Institutional Ethics Committee, Sixty Patients undergoing lower abdominal surgeries with age between 20 to 50 years, of either sex or ASA grade I and II were included in the study. Patients with any major cardiovascular, neurological, respiratory illness and who had contraindications to SAB, allergic to study drugs, patients on chronic analgesic therapy, α2 adrenergic receptor antagonists, calcium channel blockers or ACE inhibitors were excluded from the study.

After a thorough preanaesthetic check-up, patients were kept fasting overnight according to standard guide lines and premedicated with alprazolam 0.25 mg.

After obtaining a written informed consent patients were divided into two groups of 30 each by computer generated randomization. Group I received 0.5% hyperbaric bupivacaine 10mg(2ml)[14] with dexmedetomidine 5mcg in 2.5 ml and group II received 0.5% hyperbaric bupivacaine 10mg with fentanyl 25µg in 2.5 ml. Preoperatively patients were thought to read VAS scale and explained about VAS scoring.

After securing intravenous 18 G (IV) line patients were preloaded with Ringer's lactate solution of 10 mL/Kg over 30 minutes. After shifting to the operation theatre, monitors like 5 lead ECG, Non Invasive blood pressure and pulse Oximeter were applied. Baseline heart rate, blood pressure and hemoglobin oxygen saturation were noted. Lumbar puncture was performed at L_3 to L_4 interspace through midline approach with 25 G Quincke's needle. Study drug was injected at a rate of 0.2 mL/sec. Anaesthesiologist performing block was blinded and recorded study variables. Data such as vital signs were recorded every five minutes till the end of procedure and every 15 minutes till recovery. More than 20% fall in blood pressure was defined as hypotension and was treated with intravenous ephedrine incremental doses 3 to 6 mg and heart rate < 60 bpm was treated with Inj atropine 0.6 mg IV.

The study variables were

- Onset of sensory blockade time between injection of drug and onset of tingling, numbness
- Duration of motor block (assessed by modified bromage score every 10 minutes till recovery).

Modified Bromage scale.

Grade	Definition
0	No motor block
1	Inability to raise extended leg; able to move knees and feet
2	Inability to raise extended leg and move knee; able to move feet
3	Complete block of motor limb

- Duration of sensory block (Regression to S1 dermatome every 10 minutes till recovery by pinprick method
- Pain(VAS Scoring) and Time to request for first post operative analgesia and dose of analgesia required in first 24 hours was noted by the blinded anaesthesiologist who also noted adverse effects of both groups.

Diclofenac 1.5 mg/kg I.M was used as rescue analgesic postoperatively. Patients with VAS scoring up to 3/10 were considered as satisfactory analgesia.

Statistical analysis: Data was expressed as median, mean(±SD). SPSS (statistical package of social sciences) for windows version 16 software was used. To calculate sample size a p analysis of alpha =0.05 and alpha =0.90 showed thirty patients were needed per study group. Student t test was used to analyse age, weight, height, pulse rate, systolic blood pressure, diastolic blood pressure, time to t10 block, time to peak sensory block level, time to first analgesic block request. Chi square test was used to analyse maximum motor block and side effects. A probability value 'p' value of less than or equal to 0.05 was considered as statistically significant.

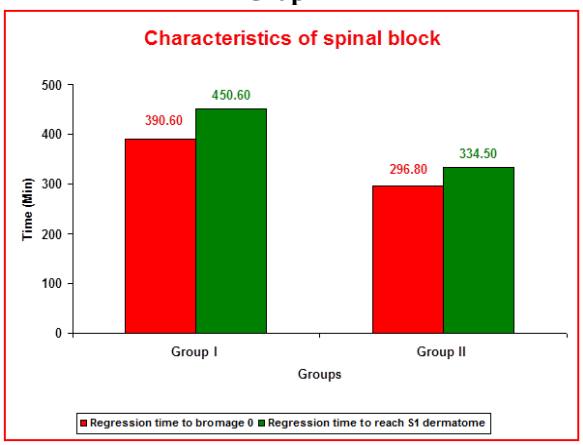
Results

Age, sex, height, weight, type and duration of surgery (Table 1) were comparable in both the groups. The duration of motor block as assessed in Group I by Modified Bromage Score was 390.6±21.8 min as compared to Group II was 296.8±15.2 min. Motor block lasted for higher duration in Group I as compared to Group II with P value <0.001.

Table 1: Demographic characteristics

Demographic Data	Group I	Group II
Number of patients	30	30
Sex (M/F)	18/12	18/12
Mean Age (Years)	54.0±6.4	52.0±6.6
Mean Height (Cms)	156.0±7.2	150.0±7.4
Mean Weight (Kg)	63.0±8.2	58.0±8.2

Graph 1



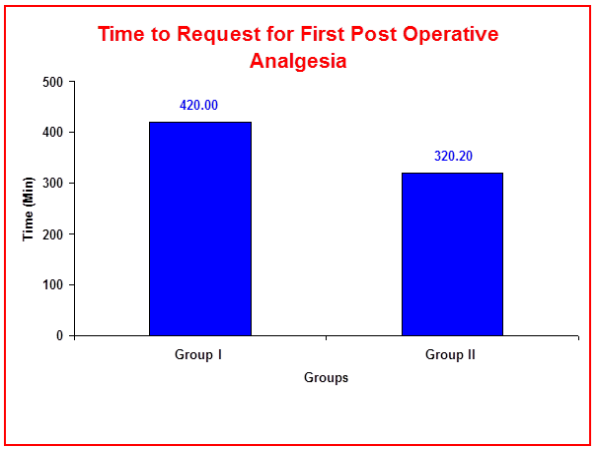
Sensory block (regression time to reach S1 dermatome) lasted for increased duration in Group I as compared to Group II (450.06±42.85 vs 334.50±24.14 minutes; p<0.001). Time request for first postoperative analgesia was significantly prolonged in dexmedetomidine group (420.00±34.87 vs 320.20±20.71 minutes; p<0.001) (Graph 1). The requirement of analgesic in first 24 hours was reduced in dexmedetomidine group compared to fentanyl group (75 vs 150 mg Diclofenac sodium) (Graph 2).

The incidence of adverse effects like pruritis, respiratory depression, nausea and vomiting, bradycardia was more in fentanyl group and incidence of hypotension was comparatively more in dexmedetomidine group (Table 2).

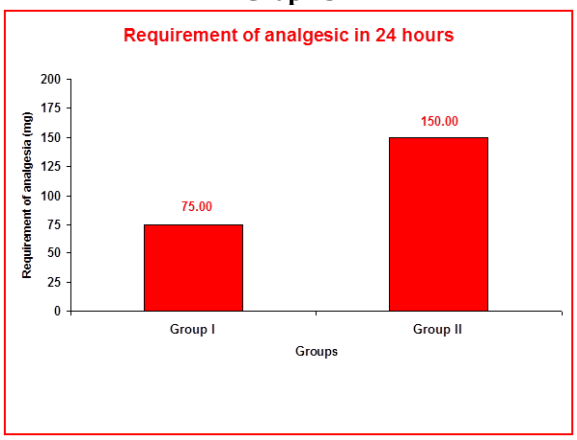
Table 2: Adverse effects

Adverse effects	Group I (n=30)	Group II (n=30)
Pruritis	0 (0%)	5 (16.66%)
Respiratory depression	0 (0%)	4 (13.33%)
Nausea vomiting	2 (6.66%)	7 (23.33%)
Bradycardia	2 (6.66%)	5 (16.66%)
Hypotension	3 (10%)	2 (6.66%)

Graph 2



Graph 3



Discussion

Spinal anaesthesia allows the patient to remain awake, reduces problems associated with airway and has less side effects and early recovery.

However postoperative pain management is a major concern in patients undergoing subarachnoid block. The use of multimodal analgesia has decreased as various adjuvants to hyperbaric bupivacaine have been used to improve quality of subarachnoid block and for satisfactory postoperative analgesia. Intrathecal fentanyl has been shown to improve quality of subarachnoid block. The combination of Fentanyl in various doses with a bupivacaine increase the duration of analgesia.[15]

Fentanyl, lipid soluble opioid acts on M1 and M2 receptor in dorsal horn of spinal and prolongs the duration of subarachnoid block.[16] It decreases calcium influx, increases potassium conductance and causes hyperpolarization of postsynaptic cell membrane. It has rapid onset of action in few minutes and decreases the dose requirement of bupivacaine. Fentanyl exhibits close structural similarities to local anaesthetics and has demonstrable local anaesthetic effect on sensory C primary afferent nerve fibers facilitating analgesia.[17,18]

Dexmedetomidine by binding to motor neurons prolong the duration of motor and sensory block. Intrathecal alpha 2 receptor agonists have antinociceptive action for both somatic and visceral pain.[19] Alpha 2 receptors are found in CNS in highest densities in locus ceruleus. A recent meta-analysis showed that intrathecal dexmedetomidine prolonged duration of spinal anaesthesia and improved postoperative analgesia and did not increase incidence of hypotension and adverse events.[20] It is site of origin for descending medullo spinal noradrenergic pathway, important modulator of nociceptive transmission, stimulation of α2 receptors in this area terminates prolongation of pain signals leading to analgesia.

Agonism at alpha 2A receptor mediates following actions sedation, hypnosis, analgesia, while agonism at alpha 2B receptors suppresses shivering centrally, promotes analgesia and induces vasoconstriction.

Agonism at 2C receptor is associated with modulation of cognition and sensory processing.[21]

Dexmedetomidine has rapid onset of action in one minute with maximum anti nociception in 20 to 30 minutes. Dexmedetomidine reduces opioid and inhalational requirement by antinociceptive action by depressing release of C fiber transmitters and hyperpolarisation of postsynaptic dorsal horn.[22] Previous studies reported prolongation of spinal block by intrathecal dexmedetomidine with no significant effect on blood pressure and heart rate or other side effects.[23]

In our study, duration of motor and sensory block was significantly prolonged in dexmedetomidine group. Similar findings were reported in a study[2] with Bupivacaine 12.5 mg and dexmedetomidine 5µg. In our study duration of motor block was 421±21 minutes, duration of sensory block was 476±20 minutes. Same study[2] reported duration of motor block as 149.3±18.2 minutes and duration sensory block 187 ±12.3 minutes with bupivacaine 12.5 mg and fentanyl 25 µg. Similar findings were reported in studies by Al-Mustafa et al[6] and Eid HEA et al.[24]

In our study, time to request for first post operative analgesia was significantly prolonged and total requirement of analgesic in 24 hours was significantly less in dexmedetomidine group. A study[2] reported 251.7±30 minutes and 80±67 mg as time for request for first post operative analgesia and total requirement of analgesic in 24 hours with Bupivacaine 12.5 mg and dexmedetomidine 5 µg whereas in fentanyl group (Bupivacaine 12.5 mg and fentanyl 25 µg) it was noted as 168.9±18 min and 180±70 mg respectively.

Limitations of the study were not recommended for day care surgeries, commercially available preparation 100 µg/ml hence not economical to use for small dosages and done in only ASA I and II grades.

Further, addition of intrathecal dexmedetomidine with intrathecal ropivacaine and lower doses of intrathecal dexmedetomidine with local anaesthesia can be studied in patients with comorbidities.

Conclusion

Intrathecal dexmedetomidine is superior to intrathecal fentanyl as an adjuvant to bupivacaine with respect to duration of motor and sensory block and time to request for first post-operative analgesia.

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