Original Research Article

Dexmedetomidine as an Intrathecal Adjuvant with Hyperbaric Bupivacaine for Lengthy Lower Limb Orthopaedic Surgeries: A Randomized Double Blinded Case Control Study

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Abstract

Background: Spinal anesthesia is efficient but of limited duration. Intrathecal dexmedetomidine prolongs the sensory and motor blockade of bupivacaine. This study has been designed to evaluate the addition of 10 µg of dexmedetomidine to 0.5% hyperbaric bupivacaine 4 ml intrathecally for elective lower limb orthopaedic surgeries. **Aims & Objectives:** To evaluate the onset and duration of sensory and motor block, the effect on hemodynamics, postoperative analgesia, and adverse effects of intrathecal dexmedetomidine with 0.5% hyperbaric bupivacaine.
Patients & Methods: This is a randomized double blinded study. Forty patients classified in ASA I & II scheduled for elective lower limb orthopaedic procedures expected to extend more than 3 hrs were studied. Patients were allocated into two groups of 20 each. Group B (n=20) received 0.5 % bupivacaine 20 mg only. Group D (n=20) received intrathecal 0.5% bupivacaine 20 mg + dexmedetomidine 10 µg. Onset and duration of the sensory block, motor block, hemodynamics, pain, and sedation were assessed intraoperatively and postoperatively for 24 hrs. The incidences of adverse effects were determined. **Results:** There was significant difference between the two groups as regards to spinal block characteristics. The mean duration of motor block in Group B and D were 195.5 and 385.5 min, respectively. The mean duration of sensory regression to L1 in Group B and D were 167.5 and 358.5 min, respectively. Time to 2-segment regression in Group B and D were 79.5 and 132.5 min, respectively. The mean duration of analgesia in Group B and D were 223.5 min and 326.5 min, respectively. The patients in Group D had significant prolongation of the motor and sensory block ($P < 0.001$). **Conclusion:** Intrathecal dexmedetomidine in the dose of 10 µg significantly prolongs the anaesthetic effects of hyperbaric bupivacaine and can be beneficial in surgeries of long duration, precluding the need for an epidural or general anesthesia.

Keywords: Spinal anesthesia, Dexmedetomidine, Analgesia, Orthopaedic surgeries.

Introduction

The anaesthetic choices for lengthy lower limbs orthopaedic procedures may comprise general anaesthesia and limited types of regional techniques such as epidural, continuous spinal, or combined nerve blocks. However, technical difficulties and lack of facilities including microcatheters or ultrasound machines may preclude some techniques. Despite the conflict, regional anesthesia may be associated with lower morbidity in major orthopaedic surgery than general anesthesia[1].0.5% Hyperbaric bupivacaine in SAB as sole local anaesthetic is associated with comparatively shorter duration of anaesthesia, analgesia and therefore patients demand for early rescue analgesic postoperatively. Adjuvants are drugs that increase the efficacy or potency of other drugs when given concurrently. Neuraxial adjuvants are used to improve or prolong analgesia, also utilized to increase the speed of onset of neural blockade (reduce latency) and prolong the duration of the neural blockade and decrease the adverse effects associated with high doses of a single local anesthetic agent.

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Dexmedetomidine is a more selective α2-adrenoceptor agonist that has been recently evaluated as an adjuvant to intrathecal local anesthesi[2-4]. Intrathecal dexmedetomidine prolongs the duration of both sensory and motor blockade in a dose-dependent manner[5].For a maximum effect, we used the recommended intrathecal (IT) dose of dexmedetomidine as 10 µg[6].This study aimed to elucidate the spinal block characteristics, analgesic, and side effects of the bupivacaine-dexmedetomidine combination.

Aims

To evaluate the onset and duration of sensory and motor block, hemodynamic effects, duration of post-operative analgesia and incidence of adverse effects of intrathecal dexmedetomidine with 0.5% hyperbaric bupivacaine in spinal anesthesia.

Patients & Methods

It was a prospective double blind randomized case control study conducted after approval from the Institutional Ethical Committee and written, informed consent from all patients included in the study. Forty patients who were scheduled to undergo two or more procedures of lower limb orthopaedic surgery expected to exceed 3 hrs were included in study. The inclusion criteria were the American Society of Anesthesiologists (ASA) I–II, both sexes, age 25–60 years. The exclusion criteria were patient refusal, cognitive impairment, intensive care admission, hypersensitivity to the study drugs, cardiac, hepatic, renal or respiratory failure, and contraindications to spinal anaesthesia. An anaesthetist not involved

in the study prepared the cocktail according to a randomization using the closed envelope method into two groups:

Group B (n=20): received spinal anesthesia with 20 mg 0.5% hyperbaric bupivacaine alone.

Group D (n=20): received spinal anesthesia with 20 mg 0.5% hyperbaric bupivacaine + 10 µg dexmedetomidine.

After the evaluation of history and investigations, patients were examined and the consent was signed. In the operation theater, appropriate equipment for airway management and emergency drugs were kept ready. An 18 G intravenous cannula was inserted, and the patient was preloaded with 10 ml/kg of lactated ringer's solution. Noninvasive blood pressure, pulse oximeter, and electrocardiogram leads were connected and baseline readings were recorded. Under aseptic precautions, a midline lumbar puncture was performed using a 26 G Quincke needle in sitting position and the drug was injected. The drug was loaded by an anaesthetist who took no further part in the study. Neither the patient nor the attending anesthesiologist was aware of the group the patient belonged to. The patient was then immediately placed in supine position. The time for intrathecal injection was considered as 0 and the following parameters were observed : sensory blockade, motor blockade, duration of analgesia and sedation. The pulse rate, systolic and diastolic blood pressure, SpO2, and respiratory rate were recorded for every 2 min for 10 min and then every 5 min throughout the intraoperative period and at the completion of surgery. Hypotension was defined as fall in systolic blood pressure > 20 % from baseline or mean arterial pressure <60 mmHg and was managed with injection mephentermine 6 mg intravenously in increments. Bradycardia was defined as heart rate <60/min and this was managed with atropine 0.6 mg intravenously. Respiratory depression defined as SpO2 <90%. This was planned to be managed by an oxygen face mask or bag and mask ventilation or intubation if necessary. Vomiting was treated with ondansetron 0.1mg/kg or metoclopramide 10 mg if persistent. Following a subarachnoid block, the sensory block was assessed by loss of sensation to pinprick using 23 G sterile needle starting immediately after injection and was continued for every 30 s till loss of pinprick sensation at T10 level. Onset of sensory block was taken as the time from intrathecal injection to loss of pinprick sensation at T10. At 20 min interval after SAB the dermatomal level of the sensory block was noted, and this was considered as the maximum level of sensory block. Motor block was assessed using Bromage score (1 - Free movements of legs and feet, 2 - Just able to flex knees with free movement of feet, 3 - Unable to flex knees but with free movement of feet, 4 - Unable to move hips, legs or feet). Assessment of the motor block was started immediately after the intrathecal injection. It was tested for every 30 seconds till Bromage Score of 4 was reached. Onset of motor block was taken as the time taken to achieve Modified Bromage score of 4 from the subarachnoid block. The degree of the motor block after 20 min of injection was noted, and this was considered the maximum degree of motor block. Thereafter, motor block regression was noted and duration of motor block was taken as the time from initiation of SAB to return to Bromage score of 1. Sedation was assessed using the Ramsay sedation score from 1 to 6. Pain was assessed using the Visual analog scale. Blood loss was replaced as necessary. The patient was shifted to a recovery room after completion of surgery. The vital signs were recorded, for every 15 min in the 1st hr after surgery and 30 mins interval for next 2 hrs and thereafter at hourly intervals for next 3 hours. Sensory and motor block assessment was done for every 15 min till recovery of pinprick sensation to L1 and Bromage score of 1, respectively. Patients were shifted to the post-operative ward after complete resolution of motor blockade. At the end of the surgery, the degree of pain was assessed using a Visual analog scale. In the recovery room, pain assessment was done for every 15 min till score >4 was reached. Whenever the patient complained of pain, the rescue analgesic intramuscular diclofenac 75 mg was given. Duration of effective analgesia was defined as the time interval between onset of the subarachnoid block and the time to reach visual analog score ≥4. Patients were monitored for 24 hrs to detect the occurrence of side effects. Patients were also enquired about the occurrence of transient neurological symptoms, which was described as pain/paraesthesia in the neck, buttocks, legs or pain radiating to lower extremities after initial recovery from anesthesia within 72 hrs.

Observation & Results

The results were computed using the Unpaired t-test. $P < 0.05$ was considered significant and $P < 0.001$ was considered highly significant.

Table 1: Demographic data

Variables	Group B (n=20)	Group D (n=20)	P value
Age (years)	43.5±13.78	34.65±10.65	0.657
BMI (kg/m2)	29±5	32±5	0.766
Male (%)	42%	35%	0.254
Female (%)	58%	65%	0.483
Duration of surgery (h)	5.1±1.2	4.8±1.	0.61

The two groups (Groups B and D) were comparable with respect to ASA class, type, and duration of surgery. The groups were similar with respect to the demographic data, i.e. age, BMI (kg/m^2) and sex with $P > 0.05$ (Table 1).

Table 2: Sensory and motor block parameters

Variables	Group B (n=20)	Group D (n=20)	P value
Onset of sensory blockade (s)	294.75±115.5	93±35.96	
Time to two segment regression (min)	88.50±14.51	138.75±75	0.0001
Sensory recovery time to L1 (min)	257.25±56.39	469.50±41.03	0.0001
Maximum sensory level attained (median)	T4	T4	0.0001
No. of diclofenac injections in first 24 h post-op (median)	8	1	0.0001
Onset of motor blockade(s)	155.25±60.44	57.75±17.73	0.0001
Motor recovery time (min)	265.50±55.72	510.50±45.18	

Sensory and motor block parameters were represented as mean ± standard deviation except maximum sensory level attained and number of diclofenac injections in the first 24 hr postoperatively which were represented as median (Table 2). There was significant shortening of the time of onset of sensory block, prolongation of time to two segment regression, and sensory recovery time to L1 in the dexmedetomidine group (Group D) compared to the Group B. The number of doses of diclofenac injections required in the first 24 hr postoperatively were also reduced in the dexmedetomidine group (Group D)compared to Group B.The patients in the dexmedetomidine group also had a significantly quicker onset of motor blockade and prolonged duration of the motor block compared to those in the Group B.

Table 3: Side effects (values expressed as numbers out of 20)

Side effect	Group B (n=20)	Group D (n=20)
Bradycardia	4	10
Hypotension	5	8
Excess sedation	0	0
Hypoxia	0	0
Anxiety	5	0
Shivering	5	5
Nausea,	1	1
vomiting	1	1
Headache	2	3
Urine retention	1	2

The dexmedetomidine group (Group D) had a significant increase in the incidence of bradycardia i.e. 50% of the patients had an episode of significant bradycardia, which was amenable to therapy with single dose of intravenous atropine 0.6 mg. Patients in the Group B had good anxiolysis, desirable sedation (Table 3).

From statistical analysis, it was computed that there was no statistically significant difference in the overall hemodynamic status of both the groups (P > 0.05) although a higher percentage of patients in the Group D developed bradycardia at some point in the course (Fig 1 and 2).

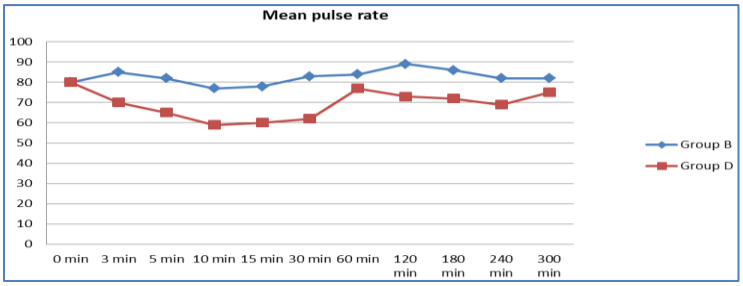

Fig 1: Mean pulse rate in both the groups at various time intervals

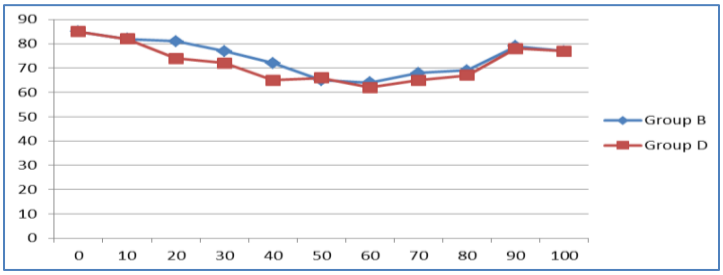

Fig 2: Means of mean arterial blood pressure in both the groups at various time interval

Discussion

Intrathecal dexmedetomidine is thought to produce its analgesic effect by inhibiting the release of C fibers transmitters and by the hyperpolarization of postsynaptic dorsal horn neurons. In our study, the mean time to onset of the sensory block is 290.5 s in Group B and 118.5 s in Group D. Onset of sensory block up to T10 is significantly faster in Group D compared to Group B. Our findings were consistent with Al-Mustafa et al. & Kim et al.Al-Mustafa et al.observed that the mean time of onset of sensory block to reach T10 was 4.7 ± 2 min in D10 group (10 µg dexmedetomidine), 6.3 ± 2.7 min in D5 group (5 µg dexmedetomidine), and 9.5 ± 3 min in Group N (control). Kim et al[7]found that the patients in dexmedetomidine group (D) demonstrated a shorter time to reach the peak sympathetic and sensory block level compared to the patients in control Group S (P < 0.01). In the present study, the mean time for two segment regression was 132.5 min in Group D and 79.5 min in Group B. The time for two segment regression is significantly prolonged in Group D (P < 0.001). In our study, there is a significant difference between two groups in terms of the time to sensory regression to L1 - with Group D requiring a much longer time (358.5 mins) compared to Group B (167.5 mins) which is highly significant with P < 0.001. Our findings were consistent with Al-Mustafa et al.& Hala et al.Al-Mustafa et al.demonstrated that the regression time to S1 dermatome was 338.9 ± 44.8 min in group D10, 277.1 ± 23.2 min in D5, and 165.5 ± 32.9 min in Group N (control) (P < 0.001). Hala et al.also concluded that dexmedetomidine significantly prolongs time to two segment regression in a dose-dependent manner (sensory regression to S1). [4-8].There was an insignificant difference among the groups in the maximum level of sensory block. The median of the maximum sensory level reached in both the groups was T4. Hala et al.(8) found that the median and range of the peak sensory level reached were T6 (T3 - T10) in Group B, T5 (T3 - T9) in Group D1, and T7 (T4 - T9) in Group D2, not statistically different among the groups (P = 0.08). Gupta et al[9] found no difference between Group D and R in the highest level of block(T5 and T6,respectively)when dexmedetomidine was added to ropivacaine as intrathecal adjuvant (D) versus control (R). There is a significant difference between groups in total duration of analgesia with Group D having a much longer duration compared to Group B (P < 0.001). Group B has a mean duration of analgesia of 223.5 min, Group D has 326.5 min. In group D only one patient (n=20) received rescue analgesia (inj. Diclofenac 75 mg i.m) in the first 24hrs compared to eight patients (n=20) in group B. Thus, the analgesic requirement in the first 24 h postoperatively in Group D was significantly lesser than that in Group B. Hala et al.observed that intrathecal dexmedetomidine in doses of 10 µg and 15 µg significantly prolong the anaesthetic and

analgesic effects of spinal hyperbaric bupivacaine in a dose-dependent manner. The mean time to onset of Bromage 2 motor block is 166.25 s in Group B and 63.5 s in Group D. There is a statistically significant difference among the groups ($P < 0.001$). It correlates with the study by Al-Mustafa et al who found that the mean time to reach Bromage 3 scale was 10.4 ± 3.4 min with 10 µg dexmedetomidine, 13 ± 3.4 min with 5 µg dexmedetomidine, and 18 ± 3.3 min in control group. Kanazi et al[10]also found that the patients who received 12 mg of bupivacaine supplemented with 3 µg of dexmedetomidine intrathecally had a faster onset of the maximum motor block compared to plain bupivacaine. The median of the maximum motor block attained is Bromage Grade 4 in both the groups. Therefore, there is no statistical difference between the groups in this regard. Hala et al.found that all the patients achieved modified Bromage 3 motor block. Kim et al.also observed that the peak block level was similar for the two groups receiving either dexmedetomidine 3 µg (n = 27) or normal saline (n=27) intrathecally with 6 mg of 0.5% hyperbaric bupivacaine. The mean duration of motor block in Groups B and D are 195.5 min and 385.5 min, respectively ($P < 0.001$). Thus, there is a significant prolongation of the duration of motor block by dexmedetomidine. Hala et al also found that motor block regression to modified Bromage 0 were significantly prolonged in Group D2 (15 µg dexmedetomidine) than in Group D1 (10 µg dexmedetomidine) and Group B (control) and in Group D1 than in Group B. Al-Mustafa et al.[4]observed that the regression to Bromage 0 was 302.9 ± 36.7 min in D10 (10 µg dexmedetomidine), 246.4 ± 25.7 min in D5 (5 µg dexmedetomidine), and 140.1 ± 32.3 min in Group N (control). In our study, there is no significant difference between the two groups with respect to intraoperative and postoperative mean heart rates with $P > 0.05$. Groups B and D have comparable values of mean systolic blood pressure, diastolic blood pressure, and mean arterial pressure throughout the intraoperative and post-operative periods with $P > 0.05$. Thus, the hemodynamic stability is maintained even in the presence of dexmedetomidine. Hala et al. found that the mean values of mean blood pressure and heart rate were comparable between the three groups throughout the study duration. Al-Mustafa et al.also observed that the three groups in their study had comparable hemodynamics throughout the period of study. The median Ramsay sedation score in both the groups is 2. Therefore, there is no significant difference although 100% of the cases in the dexmedetomidine have a desirable sedation score of 2. Al-Mustafa et al also observed that all the patients in the three groups in their study had a RSS of 2. Hala et al.found that the patients in Group B and Group D1 had a median RSS of 2 (2-3) at all assessment times ($P > 0.05$). Patients in Group D2 had a higher median sedation score (3.5-4) between 60 min and 195 min ($P < 0.05$). There was no significant difference in the sedation scores between the groups at the other time points. The incidence of hypotension and thus the use of vasopressor was significantly higher in Group D (30%) than in Group B (15%) which was insignificant statistically. The incidence of bradycardia and thus the use of atropine was significantly higher in Group D (50%) than in Group B (10%) but it was amenable to therapy with a single dose of intravenous atropine 0.6 mg. 25% of the patients in Group B were anxious whereas all the patients of the dexmedetomidine Group D were tranquil (Table 3). All the patients had peripheral oxygen saturation >95% at all times and did not require additional oxygen. Three patients each in Groups B and D had shivering, which was managed with intravenous tramadol 30 mg. Complete recovery of sensory and motor function was observed in all the studied patients. 2 weeks after the surgery at the post-operative follow-up visit, patients did not show any neurological deficit.

Conclusion

The longer sensory and motor blockade produced by 10 µg dexmedetomidine with hyperbaric bupivacaine and the desirable level of sedation can be beneficial in surgeries of long duration, precluding the need for an epidural or general anaesthesia.

Conflict of Interest: Nil
Source of support:Nil

References

1. Helwani MA, Avidan MS, Abdallah AB et al. Effects of regional versus general anesthesia on outcomes after total hip arthroplasty: a retrospective propensity-matched cohort study. JBJS. 2015; 97(3):186–193.
2. Al-Ghanem SM,Al-Zaben K, Qudaisat IY, Qatawneh AM. Effect of adding dexmedetomidine versus fentanyl to intrathecal bupivacaine on spinal block characteristics in gynecological procedures: A double blind controlled study. Am J Appl Sci. 2009; 6:882-7.
3. Kanazi GE,Jabbour-Khoury SI, Al Jazzar MD, Alameddine MM, AlYaman R et al. Effect of low-dose dexmedetomidine or clonidine on the characteristics of bupivacaine spinal block. Acta Anaesthesiol Scand. 2006; 50:222-7.
4. Al-Mustafa MM, Murshidi MM, Ammari BA, Awwad ZM et al. Effect of dexmedetomidine added to spinal bupivacaine for urological procedures. Saudi Med J. 2009; 30:365-70.
5. Gosavi KS, Swami SR. Comparison of three different doses of dexmedetomidine in subarachnoid block as an adjunct to bupivacaine in lower limb orthopaedic surgery. Indian J Appl Res. 2018; 8(7):64–67.
6. Naaz S,Asghar A. Optimal dose of intrathecal dexmedetomidine in lower abdominal surgeries in average Indian adult. J Clin Diagn Res. 2016; 10(4):UC09–UC13.
7. Kim JE, Kim NY, Lee HS, Kil HK. Effects of intrathecal dexmedetomidine on lowdose bupivacaine spinal anesthesia in elderly patients undergoing transurethral prostatectomy. Biol Pharm Bull. 2013; 36:959-65.
8. Hala EE, Mohamed SA, Hend Y. Dose-related prolongation of hyperbaric bupivacaine spinal anesthesia by dexmedetomidine. Ain Shams J Anesthesiol. 2011; 4:83-95.
9. Gupta R, Bogra J, Verma R, Kohli M, Kushwaha JK, Kumar S. Dexmedetomidine as an intrathecal adjuvant for post-operative analgesia. Indian J Anaesth. 2011; 55:347-51.
10. Kanazi GE, Aouad MT, Jabbour-Khoury SI, Al Jazzar MD, Alameddine MM, AlYaman R et al. Effect of low-dose dexmedetomidine or clonidine on the characteristics of bupivacaine spinal block. Acta Anaesthesiol Scand. 2006; 50: 222-7.