Original Article

Indian Journal of Anaesthesia and Analgesia
2017, 4 (3, Part-II), 822-826
DOI: http://dx.doi.org/10.21088/ijaa.2349.8471.4317.44

Comparative Study between Intrathecal Dexmedetomidine and Intrathecal Magnesium Sulphate as an Adjunct to Bupivacaine in Spinal Anesthesia for Lower Limb Orthopaedic Surgeries

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Abstract

Introduction: In order to maximize quality of anesthesia and effective analgesia, a number of adjuvants have been added to intrathecal local anesthetics but none of them have yet been identified without any adverse events. *Material & Methods:* 90 patients scheduled for lower limb orthopaedic surgery under spinal anaesthesia were included in this prospective randomized double blind study. Patients were randomly allocated into any of three groups. Group A– Patients receiving 0.5% hyperbaric bupivacaine 3ml (15mg) + 0.1ml (10µg) dexmedetomidine hydrochloride. Group B- Patients receiving 0.5% hyperbaric bupivacaine 3ml (15mg) + 0.1ml (50mg) magnesium sulphate. Group C - Patients receiving 0.5% hyperbaric bupivacaine 3ml (15mg) + 0.1ml normal saline as control. The onset time for sensory and motor block, the regression time for block, duration of effective analgesia, hemodynamic parameters and any adverse events were recorded at timely intervals. *Results:* The onset time of sensory and motor block was faster with Group A (2.16 and 3.30 min) as compared to Group C (3.72 and 4.88 min), whereas it was significantly prolonged with Group B (6.1 and 7.03 min). Duration of sensory and motor block was significantly prolonged with Group A (344.67 and 318.67 min) and to a lesser extent with Group B (273 and 246 min) when compared to control Group (195 and 169.5 min). The duration of effective analgesia was longer with Group A (375 min) and Group B (294.3 min) when compared with Group C (216 min). *Conclusion*: Addition of Dexmedetomidine as an adjuvant to hyperbaric Bupivacaine intrathecally leads to rapid onset and prolonged duration of anesthesia. With intrathecal Magnesium sulphate, the onset of block was delayed but the duration of block was prolonged although to a lesser extent. Duration of effective analgesia was prolonged in both the study groups although more pronounced with Dexmedetomidine. Hemodynamic parameters where stable in all the three study groups without any significant group specific side effects.

Keywords: Bupivacaine; Dexmedetomidine; Magnesium Sulphate; Spinal Anesthesia; Orthopaedic Surgery.

Introduction

Anaesthesiologists should aim to render the patient pain free, not only during surgical procedure, but also post-operatively. Spinal block is preferred for lower limb orthopaedic surgeries due to its rapid onset, low risk of infection, less failure rate in experienced hands, cost effectiveness and numerous other advantages of regional anesthesia. The versatility of spinal anesthesia was increased with introduction of intrathecal adjuvants which allowed control over level of block, time of onset, duration of block & prolonged analgesia which aided in accelerated functional recovery of the patients [1].

Dexmedetomidine is a highly selective alpha 2 agonist (1640:1) which has its anti-nociceptive effects at both supra-spinal and spinal level [2]. Magnesium is a non-competitive antagonist to NMDA receptor and it attenuates or even prevents central

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Received on 05.05.2017, **Accepted on** 12.05.2017

sensitization after peripheral tissue injury or inflammation because of inhibition of dorsal horn NMDA receptors at spinal level. Effects are primarily based on regulation of calcium influx into cells (Natural Physiological calcium antagonism) [3,4]. Intrathecal magnesium prolonged spinal block with improved post-op analgesia

Material and Methods

After obtaining institutional ethical clearance and written informed consent, 90 patients of either sex, ASA grade 1 & 2, age 18-60 years, height 150-180cms posted for lower limb orthopaedic surgeries under spinal anesthesia were randomly allocated into any of the 3 groups. Patients who had any contraindications to regional anesthesia, any hepatic, renal, pulmonary, cardiac diseases, uncontrolled hypertension, any history of addiction to sedative drugs, allergy to study drugs were excluded from the study. The patients were randomly allocated into three groups:

Group A – Patients receiving 0.5% hyperbaric bupivacaine 3ml (15mg)+0.1ml (10μg) dexmedetomidine hydrochloride

Group B - Patients receiving 0.5% hyperbaric bupivacaine 3ml (15mg) + 0.1ml (50mg) magnesium sulphate

Group C - Patients receiving 0.5% hyperbaric bupivacaine 3ml (15mg) + 0.1ml normal saline as control.

Detailed pre-anaesthetic check up was done 1 day prior and NPO status was maintained for 6 hours. Upon arrival to operation theatre, standard monitors were attached which included ECG, Pulse oximetry & NIBP. Intravenous line was secured with18g cannula and patients were preloaded with 10ml/kg ringer lactate.

Under strict aseptic precautions and after local skin infiltration, Lumbar puncture was performed in sitting position, by midline approach, using 25G disposable Quincke's spinal needle at L3-L4 intervertebral space. Free and clear flow of CSF was confirmed and with the direction of bevel of spinal needle facing cephaloid, study drug was slowly instilled intrathecally (0.2ml/sec). Patients were made supine immediately and time of drug administration was noted as 0 minutes. Oxygen supplementation with face mask (5lit/min) was given.

The study was aimed to compare onset of sensory and motor block, duration of sensory and motor block, timing of rescue analgesia, any changes in hemodynamic parameters and study any adverse events. The time of onset of sensory block was taken from the time of injection of drug intrathecally to loss of pin-prick sensation using sterile hypodermic needle at T_{12} dermatomal level every 30 seconds after positioning and time interval was noted. The duration of sensory block was taken as time from onset to time of return of pin-prick sensation using hypodermic needle to S1 (heel) dermatomal area. It was tested at every 10min interval post-operatively and the time was noted as duration of sensory block.

The time interval between drug instillation and the patient's inability to move hip, knee or ankle (modified bromage scale grade 3) was taken as onset time. Patients were asked to move lower limb at 30 seconds interval and time interval was recorded. The duration of motor block was taken from time of injection to complete regression of motor block i.e. ability to move hip, knee & ankle. Patients were asked to move limbs at 10min interval postoperatively and the time interval was recorded as duration of motor block.

Analgesics were avoided until demanded by the patient. The time interval for the first analgesic consumption was noted as time for rescue analgesia. Pain assessment was done by visual analogue score (0-10).

Vital parameters like Heart rate, blood pressure, SPO_2 and respiratory rate were recorded intraoperatively and postoperatively till recovery of sensory block. Any intra-operative adverse events like nausea, vomiting, pruritis, sedation, respiratory depression or any post-operative events such as urinary retention, sedation etc. also recorded. Any event of bradycardia (heart rate less than 60 beats/min) or hypotension (systolic blood pressure less than 90mm of hg or more than 30% decline from baseline values) were noted and accordingly treated with atropine or mephenteramine boluses. Statistical analysis was done using INSTAT for windows statistical Analysis Software. The values were represented in Numbers, percentage and Mean ± SD.

Results

Demographic profile were comparable in all groups and found to be statistically insignificant.

The mean time of onset of sensory and motor block in group A was 2.16±0.44 and 3.3 ± 0.52 min. In Group B it was 6.1± 0.7 and 7.03 ± 0.75 min. The time of onset of sensory block and motor block in group c was 3.72 ± 0.67 and 4.88±0.64 min. On comparing the values

of onset time of sensory as well as motor block among the three groups, it was found to be highly significant ($p < 0.001$)

The mean time of offset of sensory and motor block in group A was 344.67±36.08 and 318.67 ± 35.01 min. In group B sensory block duration was 246±36.63 and motor block lasted for 273± 37.06 min. Sensory and motor block in group C was 195±27.39 and 169.5±29.31 min. On analyzing the data obtained statistically it was found to be highly significant when compared among the three groups

The timing of rescue analgesia was interpreted as duration of effective analgesia. It was given on patient's demand or when VAS score [3,4]. The mean time of effective analgesia in Group A was 375 ± 31.12 min., while in group B and group C was 294.3 ± 38.05 and 216±29.28 minutes respectively. On comparing the data among three groups, it was found to be statistically highly significant ($p<0.001$).

Haemodynamic parameters were stable and comparable in all three groups and were statistically insignificant. There were no group specific haemodynamic adverse events in any group.

No group specific adverse events were observed during the study. Hypotension was observed in five patients in group A; four patients in group B and five in group C. Bradycardia was observed in two patients in group A & group C and in one patient in group B. Nausea and vomiting was observed in one patient in group C and none in group A & B. Shivering was observed in one patient in each group. Patients in group A was found more sedated compared to group B & C. None of the patients in any study group had pruritis. Respiratory depression was found in only one patient in group A.

Table 1: Demographic Profile

	Group A	Group B	Group C	Anova summary
Mean age	42.43±13.33	40.43±13.49	43.6±13.79	F = 0.41 P=0.66
Gender distribution:				
Male	19 (63.3%)	23 (76.6%)	22 (73.3%)	----
Female	11 (36.6%)	7 (23.3%)	8 (26.6%)	
Mean height	159.1±28.14	164.3±7.08	162.36±7.71	F=0.68 P=0.51

Table 2: Block characterstics. (All values in Mean Minutes ± SD)

	Group A	Group B	Group C
Onset of sensory block	2.16 ± 0.44	6.1 ± 0.7	3.72 ± 0.67
Onset of motor block	3.3 ± 0.52	7.03 ± 0.75	4.88 ± 0.64
Offset of sensory block	344.67 ± 36.08	273 ± 37.06	195 ± 27.39
Offset of motor block	318.67 ± 35.05	246 ± 36.63	169.5 ± 29.31
Mean time for rescue analgesia	375 ± 31.12	294.3 ± 38.05	216 ± 29.28

Table 3: Annova Analysis summary

	Gr. A vs Gr. B		Gr. A vs Gr. C		Gr. B vs Gr. C	
	t	p	t	p	t	P
Onset of sensory block	26.03	< 0.001	10.63	< 0.001	13.52	< 0.001
Onset of motor block	22.35	< 0.001	10.54	< 0.001	11.92	< 0.001
Offset of sensory block	7.59	< 0.001	18.10	< 0.001	9.27	< 0.001
Offset of motor block	48.56	< 0.001	17.89	< 0.001	30.14	< 0.001
Mean time for rescue analgesia	8.20	< 0.001	18.12	< 0.001	8.94	< 0.001

Table 4: Adverse Events in study groups

	Group A	Group B	Group C
Hypotension	5	4	5
Bradycardia	2	1	2
Nausea/vomiting	0	0	1
Shivering	1	1	1
Sedation	4	1	2
Pruritis	0	0	0
Respiratory depression	1	0	0

Discussion

With wide range of lower limb orthopaedic surgeries being performed under regional anesthesia, neuraxial blockage has its own demerits and limitations. In recent years numerous adjuvants have been tried intrathecally which allowed control over level of block, time of onset, duration of block and prolonged analgesia which aided in accelerated functional recovery of patients.

In our study, the mean time of onset of sensory and motor block in group A was 2.16 ± 0.44 and 3.3 ± 0.52 min whereas in group B was 6.1 ± 0.7 and 7.03 ± 0.75 min. In group C (Control) it was 3.72 ± 0.67 and 4.88 ± 0.64 min. the duration of sensory and motor block in group A was 344.67± 36.08min and 318.67± 35.01 min and in group B it was 273 ± 37.06 min and 246± 36.63 min whereas in group C it was found to be 195 ± 27.39 min and 169.5±29.31 min (Table 2) and was statistically significant (P<0.001).

Thus onset was faster in group A and slower with group B when compared to group C. However duration of block was more in group A and group B compared to control group. Duration of effective analgesia & need for rescue analgesia was found to be after 375±31.12 min with group A and 294.3± 38.05 min in group B while in group C it was after 216 ± 29.28 min. (Table 2).

Shukla D. et al [5]evaluated dexmedetomidine (10µgm) and magnesium sulphate (50 mg) given intrathecally as an adjunct to bupivacaine for lower limb and lower abdomen surgeries under spinal anesthesia and found that onset of sensory and motor block was faster in Dexmedetomidine group (2.27 ± 1.09 and 3.96 ± 0.92 min). In magnesium group it was found to be 6.46±1.33 and 7.18±1.38 min while in control group it was 4.14±1.06 and 4.81±1.03 min. Duration of motor and sensory block in Dexmedetomidine group to be 331±35 and 352± 45 min. With magnesium it was 251±51 and 265±65 min whereas in control group it was 140±34 and 194 ± 55 min.

Malleswaran S et al [6] in their study included sixty women with mild preeclampsia undergoing caesarean section under spinal anesthesia with either fentanyl or magnesium sulphate as an adjunct to bupivacaine in spinal anesthesia. Onset of sensory block was found to be 8.7±0.9 min in magnesium group and 7.7±0.8 min in control group (p<0.001). Onset of motor block was found as 9.2±0.8 and 8.9±1.0 min in magnesium and control group respectively (p=0.214) and concluded slower onset of both sensory and motor block. The duration of spinal anesthesia and motor block were significantly longer with increase in duration of effective analgesia (229±15.1 min) when magnesium sulphate was used as an adjunct to bupivacaine intrathecally.

Mridu Paban Nath and colleagues [7] evaluated intrathecal magnesium sulphate for hysterectomy under spinal block and concluded that onset of sensory and motor block was significantly prolonged. However duration of block was increased with intrathecal magnesium as an adjunct with increased duration of analgesia (291.4±18.6 min).

Kanazi G E et al [8] used dexmedetomidine as an adjuvant to bupivacaine in spinal anesthesia for patients undergoing transurethral resection of prostate or bladder tumor and found that onset time for peak sensory level and motor block was faster with dexmedetomidine and clonidine when compared to control group. Duration of block was significantly prolonged in group with dexmedetomidine.

Hemodynamic parameters like heart rate, systolic blood pressure, diastolic blood pressure, mean blood pressure remained stable in all three groups and showed no group specific significant variation. Oxygen saturation was maintained throughout the procedure & there were no inter group significant difference.

Hypotension, bradycardia, nausea, vomiting were major adverse events but there was no significant difference among the study groups.

Shukla D. et al [5] also found no incidence of any side effects in either group compared to control and both groups had comparable hemodynamic parameters. There were no significant side effects in either of the groups. They found no difference in the mean values of heart rate and mean arterial pressure in all the groups.

Nidhi Bidyut Panda & Selva Kumar [9] compared intrathecal magnesium & fentanyl as adjunctive with bupivacaine in preeclamptic patients. Hemodynamic parameters were comparable in both groups. The incidence of side effects such as sedation, nausea, vomiting and pruritis was comparable in between the groups. No additional side effects such as hypotension or respiratory depression were noted in the magnesium group.

Malleeswaran S. et al [6] and Kanazi G. E. et al [8] also concluded that hemodynamic parameters and side effect profile were similar with the control group and there were no significant adverse events.

Conclusion

Adding Dexmedetomidine 10 μg to single shot spinal blockade with hyperbaric 0.5% Bupivacaine 15 mg not only provides rapid onset and prolonged duration of sensory and motor blockade but also extends the duration of post operative analgesia without significant adverse effect. The overall effect and duration is superior to addition of 50mg of magnesium sulphate. Addition of Dexmedetomidine intrathecally didn't had any adverse effects on cardiovascular stability in comparison to control.

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