Journal of Advanced Medical and Dental Sciences Research

@Society of Scientific Research and Studies ***NLM ID:*** *101716117*

Journal home page: www.jamdsr.com doi: 10.21276/jamdsr Index Copernicus value = 85.10

(e) ISSN Online: 2321-9599; (p) ISSN Print: 2348-6805

Original Research

Comparison of Dexmedetomidine and Fentanyl as Adjunct to Hyperbaric Bupivacaine in Subarachnoid Block for Lower Limb Surgeries

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ABSTRACT:

Background: Spinal anaesthesia is most popular anaesthetic technique for surgeries involving lower part of body. Most common drug used is hyperbaric bupivacaine 0.5%. Various adjuvants are being used to potentiate the effect of analgesia and prolong the anaesthetic effect. Most common drug used as adjuvant is fentanyl. Dexmedetomidine is relatively newer adjuvant, which is being evaluated and compared with fentanyl in this study for its potency and efficacy. **Aim**: The aim of our study was to test and compare the efficacy of Dexmedetomidine with Fentanyl as adjuvant to hyperbaric Bupivacaine in spinal anaesthesia in lower limb surgeries. **Settings and design**: Prospective randomized double blind study in the setting of a tertiary care hospital. **Material & Methods:** Total 60 patients were enrolled in the study and were randomized and divided into two groups on the basis of adjuvants, group D (Dexmedetomidine 5 mcg), group F (Fentanyl 20 mcg) with hyperbaric Bupivacaine 0.5%. After giving neuraxial block, effect of drugs were evaluated noting time, frequency and dose of rescue analgesia, modified Bromage scale, sensory level and duration of block and other hemodynamic parameters. Side effects like nausea, vomiting, pruritis, bradycardia, hypotension were also noted. **Results**: All demographic parameters were comparable in all groups. Time to rescue analgesia were statistically significant, showing longer sensory block and more effective analgesia in group D. Similar results were found for motor block ascertained by modified Bromage score. Evidence of significant bradycardia was noted in group D intraoperatively. Other parameters were comparable among all groups. **Conclusion**: Dexmedetomidine as adjuvant to hyperbaric bupivacaine in neuraxial blockade prolongs analgesic effect as well as motor block more than Fentanyl. There were no significant side effects noted except bradycardia in Dexmedetomidine group.

Keywords: Dexmedetomidine, Spinal Adjuvant, Fentanyl

Received: October 20, 2020 Accepted: November 27, 2020

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This article may be cited as: Ramprasad R, Anand R, Chaudhary V. Comparison of Dexmedetomidine and Fentanyl as Adjunct to Hyperbaric Bupivacaine in Subarachnoid Block for Lower Limb Surgeries. J Adv Med Dent Scie Res 2021;9(1):19-23.

INTRODUCTION

Spinal anaesthesia is the most common and suitable modality of anaesthesia for lower limb surgeries. Spinal anaesthesia requires a small volume of drug, virtually devoid of systemic pharmacologic effects, to produce profound, reproducible sensory analgesia.[1]

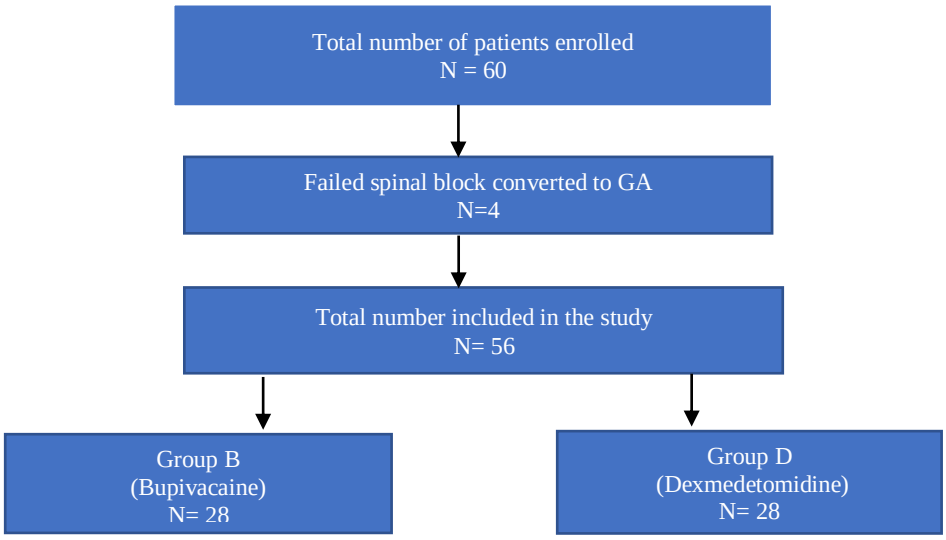
Spinal anaesthesia with Lignocaine was highly popular earlier for short surgical procedures as it had a predictable onset and provided dense sensory and motor blockade of moderate duration. However, in view of reported phenomenon of 'Transient Neurological Symptoms with Lignocaine and its shorter duration of action,[2] hyperbaric Bupivacaine (0.5%) has replaced Lignocaine as the drug of choice for safe conduct of spinal anaesthesia in recent times. Sensory and motor blockade with Bupivacaine is satisfactory, but its duration of action, though longer than that of lignocaine is limited,[3] hence adjuvants were introduced for producing prolonged post-operative analgesia. The discovery of opioid receptors and endorphins in spinal and supra spinal regions soon led to the use of spinal opioids as spinal adjuvants.[4] Phenylephrine, Neostigmine, Ketamine, Midazolam, Clonidine & Dexmedetomidine are some of the other well-known agents used as adjuvants.

Neuraxial administration of opioids along with local anaesthetics improves the quality of intra-operative analgesia and also provides post-operative pain relief of longer duration. Fentanyl, a highly lipophilic opioid has rapid onset of action following intrathecal administration and is 80-100 times more potent than morphine is also associated with fewer side effects as compared to morphine and has become a very popular adjuvant to hyperbaric Bupivacaine in recent times.[5]
Dexmedetomidine, a highly selective α-2 agonist, is approved as an intravenous sedative and co-analgesic drug.[6] Intrathecal and epidural characteristics of dexmedetomidine have been studied in animals.[7,8] It was first used as intrathecal adjuvant in humans for Transuretheral resection of prostate.[9]
Fentanyl has been widely used as adjunct to hyperbaric bupivacaine, whereas Dexmedetomidine is a newer adjunct to hyperbaric Bupivacaine. There are no studies in literature which have compared the two drugs as adjuncts to intrathecal Bupivacaine in lower limb surgeries.

MATERIALS AND METHODS

This prospective randomized control study was conducted at a tertiary care teaching hospital after being duly approved by ethical committee. A total of 60 patients in the age group between 20 and 70 years of either sex in American Society of Anaesthesiologists physical status I and II scheduled for elective lower limb surgeries including orthopedic and vascular surgical procedures were randomly divided in to two groups of 30 each. Patients with cardiac diseases, bleeding diathesis, on anticoagulation therapy, pregnancy and any contraindications to spinal anaesthesia were excluded from the study. The patients were randomized by computer generated numbers in to two groups of 30 each, group F (Fentanyl) and group D (Dexmedetomidine). Group F received Fentanyl 20 mcg and group D received 5 mcg Dexmedetomidine as adjuvants to hyperbaric 0.5% Bupivacaine 3 ml. The drug preparations were loaded by an anaesthesiologist not involved in the study.
All the patients were managed as per institutional protocol perioperatively. They were preloaded with Ringer lactate solution 10 ml/Kg over 15 – 20 minutes. The monitoring included Non Invasive Blood Pressure (NIBP) in fore arm, pulse oximetry, ECG for heart rate, rhythm and any signs of ischemia and respiratory rate. After the base line parameters were recorded patients were administered spinal anaesthesia with 25 G Quincke's needle in sitting position in L2-3/L3-4 interspace, the drug was injected after ascertaining free flow of CSF. The patients were made supine and the level of sensory and motor block was tested using pin prick and modified Bromage scale methods respectively. Failure of block was managed with administering general anaesthesia and those patients were excluded from the study. Hemodynamic variables were recorded every 3 minutes for first 15 minutes after administration of subarachnoid block, every 5 minutes till one hour and every hour after patients were shifted to postoperative ward for next 12 hours. Episodes of bradycardia were managed with Inj Atropine 0.3 mg iv, which was defined as HR< 40/min for > 30 sec. Episodes of hypotension were managed with Inj Mephenteramine 3 mg iv in each episode, hypotension was defined as MAP >20% drop in baseline for > 60 sec. Note was made of any adverse reaction like nausea, vomiting, shivering, respiratory depression in addition to hemodynamic disturbances. Injection Tramadol 50 mg bolus IV was given as rescue analgesia on demand. Duration of demand for first rescue analgesia was noted and this period from the administration of block was taken as duration of effective analgesia by the block.

Figure A - Flow of patients



STATISTICAL ANALYSIS

Statistical analysis was done by using statistical software SPSS 17.0. Normally distributed measurable data over the two groups were compared using Student's t-tests; whereas for skewed data (non-normally distributed) over the two groups was compared using Mann Whitney test.

The data were presented with descriptive statistics with mean ± SD or median and inter-quartile range as also their minimum and maximum values, depending upon whether the data was normally distributed or skewed. For Categorical / Classified data, their association with the two groups was analyzed using Chi-Square test or Fisher's exact test.

RESULTS

A total of 60 patients were enrolled in the study, 04 patients two in each group had failure of spinal anaesthesia, were administered GA and excluded from the study. The two groups were demographically comparable (Table -1). The parameters related to subarachnoid block are as in Table 2. The time of onset of sensory block and motor block were comparable in both the groups 3.8 ± 0.8 and 4.1 ± 0.9 minutes and 3.92 ± 1.0 and 4.18 ± 0.8 minutes in group F and group D respectively. Time of regression of sensory block was significantly longer in group D (389 ± 72.4 minutes) compared to group F (239 ± 58.6 minutes). Similarly time of regression of motor block to modified Bromege scale to 0 was significantly longer in group D (346 ± 67.8 minutes) compared to group F (216 ± 46.7). Time to first rescue analgesia signifying the duration of analgesia of the block was significantly longer in group D compared to group F (p value <0.05). The hemodynamic variations at various time intervals are as per Table 3 and Table 4. The Mean arterial pressure (MAP) fell in both the groups the fall was comparable and not significant. The heart rate also consistently fell in both the groups but the fall was significantly more marked in group D at 6, 9, 12. 15 minutes after the block the fall was non-significant after 15 minutes till 45 minutes. The complications requiring interventions were comparable in both the groups except bradycardia which was seen in 25% of patients in group D compared to 14% in group F. Pruritus was seen in 10.7% cases in group F compared to 3.5% patients in group D.

Table -1 Demographic Details

Parameters	**Group F**	**Group D**	**P - Value**
Mean age (Years)	44 ± 6.2	416 ± 3.6	0.22
Mean weight (Kg)	65.2 ± 4.2	68 ± 4.0	0.16
Mean height (cms)	164.4 ± 7.6	168.6 ± 6.2	0.30
Mean BMI (Kg/m^2)	24.2 ± 1.8	24.09 ± 2.1	0.44
Sex M F	16 14	.17 .13	0.18
Mean surgery duration (Min)	62.8 ± 8.1	66.6 ±9.1	0.20

- Mean ± Standard deviation

Table 2 – Parameters related to subarachnoid block

Parameters	**Group F (n=28)**	**Group D (n=28)**	**p - value**
Onset of sensory block (min)	3.8 ± 0.8	3.92 ± 1.0	0.65
Onset of motor block (min)	4.1 ± 0.9	4.18 ± 0.8	0.92
Time for regression of sensory block (min)	239 ± 58.6	389 ± 72.4	**0.003***
Time for regression of motor block (modified Bromege score to 0)	216 ± 46.7	346 ± 67.8	**0.018***
Time to first rescue analgesia (min)	242 ± 38.6	386 ± 78.8	**0.02***
Total dose of Tramadol in 24 hours (mg)	225 ± 30	235 ± 45	0.15

*significant p value

Table 3 Variations in HR between the two groups

Time Interval	Mean Heart Rate beats/min (SD)		P- Value
	Group F	Group D	
Before the block (Baseline)	76.8 (10.20)	78.2 (11.6)	0.18
After 3 minutes	74.7 (10.8)	76.9 (10.2)	0.12
After 6 mins	72.8 (9.8)	64.7 (10.8)	0.02*
After 9 mins	70.9 (8.6)	62.8 (9.7)	0.03*
After 12 mins	68.2 (11.2)	63.6 (11.4)	0.04*
After 15 mins	70.9 (9.6)	62.2 (7.8)	0..02*
After 30 mins	71.1 (10.2)	65.1 (9.4)	0.09
After 45 mins	72.2 (11.6)	68 (9.8)	0.20

HR – Heart Rate SD – Standard Deviation P value < 0.05 – significant *

Table 4- Variations in MAP between the two groups

Time Interval	MAP mm Hg (SD)		P- Value
	Group F	Group D	
Before the block (Baseline)	89.9 (9.1)	92.8 (8.6)	0.29
After 3 minutes	65.9 (8.8)	67.2 (11.2)	0.20
After 6 mins	62.0 (9.2)	59.2 (8.2)	0.15
After 9 mins	68.9 (10.1)	66.7 (9.6)	0.30
After 12 mins	66.2 (10.6)	69.4 (10.6)	0.15
After 15 mins	63.8 (9.6)	66.8 (7.8)	0.20
After 30 mins	74.3 (8.6)	71.7 (9.2)	0.14
After 45 mins	73.8 (11.2)	72.8 (12.2)	0.2

MAP – Mean Arterial Pressure SD – Standard Deviation. P value < 0.05 – significant *

Table 5: Complications requiring interventions

	Group F n = 28 (%)	Group D n = 28 (%)	P Value
Bradycardia	4 (14.2)	7 (25)	**0.04 ***
Hypotension	11 (39.2)	12 (42.8)	0.12
Pruritus	3 (10.7)	1 (3.5)	**0.03***
Nausea	4 (14.2)	5 (17.8)	0.2
Vomiting	3 (10.7)	2 (7.1)	0.1
Respiratory depression	3 (10.7)	2 (7.1)	0.1

*Significant p value

DISCUSSION

Subarachnoid block is the preferred mode of anaesthesia for surgeries of lower abdomen, pelvic organs and lower limbs because of its rapid onset, superior blockade, low risk of infection, less failure rate and cost effectiveness. One of the major limitations for sub-arachnoid block is its short duration of block and limited post-operative analgesia. To overcome this limitation, various adjuvants have been tried with local anaesthetics, their use being limited either due to the adverse effects or unreliable post-operative analgesia.

In this prospective, randomized double blind study, Dexmedetomidine and Fentanyl were compared as adjuvants to intrathecal hyperbaric bupivacaine in subarachnoid block for different surgeries involving lower limbs.

Dexmedetomidine group was found to be having significantly longer analgesic effect than Fentanyl group. Group D had higher time to rescue analgesia suggesting longer sensory block. Time to rescue analgesia is calculated as the time when the first dose of rescue analgesia is given to the patient. The p value for time to rescue analgesia in our study was <0.001 which was statistically significant. Subhi M et al evaluated the onset and duration of sensory and motor block as well as operative analgesia and adverse effects of 5µg Dexmedetomidine and 25µg Fentanyl given intrathecally with 10mg plain 0.5% Bupivacaine for spinal anesthesia in seventy six patients.[10] The authors had concluded that women undergoing vaginal reconstructive surgery under spinal anaesthesia, 10 mg plain Bupivacaine supplemented with 5 µg Dexmedetomidine produced prolonged motor and sensory block compared with 25 µg fentanyl as adjuvants. Gupta R et al,[11] in their study also used 5µg dexmedetomidine and 25µg fentanyl as adjuvants to intrathecal hyperbaric Bupivacaine and came to the same conclusion. Mahendru et al compared 5µg Dexmedetomidine, 30µg Clonidine and 25µg fentanyl as adjuvants to intrathecal hyperbaric bupivacaine and the authors concluded that dexmedetomidine prolonged both sensory and motor block.[12] The longer duration of analgesia with Dexmedetomidine observed in our study is in concurrence with the findings of the study conducted by these authors. The total dose of rescue analgesic in the form of Inj Tramadol 50 mg iv, was not significantly different between the groups.

Our study found that Dexmedetomidine group had higher modified Bromage scores than Fentanyl group and longer time to return to modified Bromege score to zero suggesting longer duration of motor block. Studies conducted by Shubi M et al,[10] Gupta R et al[11] and Mahendru et al[12] also concurred with our findings of longer duration of motor block with Dexmedetomidine compared with Fentanyl, Clonidine and Bupivacaine alone.

The most significant side effects reported with the use of intrathecal α2 agonists is bradycardia. In our study there was a significant fall in the heart rate in Groups D as compared to group F. 25% patients in group D required intervention for significant bradycardia the corresponding figures for group F were 14%. Intraoperative changes in mean arterial pressures were comparable in both the groups and there was a consistent fall in MAP in both the groups. These hemodynamic findings were similar to findings in other similar studies by Mahendru V et al,[12] Halder S et al,[13] Mahima Gupta et al,[14] Kanzi et al[9] and Subhi M et al.[10] No patient in our study had fall in oxygen saturation or significant respiratory depression.

Patients in all groups were evaluated for common adverse events like nausea, vomiting, hypotension,

bradycardia, pruritus and respiratory depression. The episodes of nausea, vomiting were comparable in both groups. Episodes of respiratory depression were higher in the fentanyl group but were not statistically significant. Occurrence of pruritus was higher in group F (10.7%) compared to group D (3.5%) and was found to be statistically significant.

LIMITATIONS

The study was conducted upon relatively healthier population (ASA grade I and II). Patients with severe co-morbidities have not been included in this study. Age group was restricted to 70 years, hence results cannot be extrapolated to older patients undergoing similar procedures under subarachnoid block.

CONCLUSION

Dexmedetomidine in the dose of 5 µg intrathecally as adjuvant to hyperbaric bupivacaine prolonged the duration of both sensory and motor block as compared to 20 µg fentanyl with hyperbaric Bupivacaine. It was found to be superior to 20 mcg Fentanyl with comparable adverse side effects and was found to be safe.

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The study was carried out in a government institute and no grant or financial support was taken from any agencies.