Original Article

"A Comparative Study between Hyperbaric Bupivacaine with Fentanyl and Hyperbaric Bupivacaine with Dexmedetomidine in Spinal Anesthesia for Lower Limb Orthopedic Surgery"

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ABSTRACT

Introduction: *Lower limbs surgery is a wide known phenomenon in the field of medical science, research and technology and spinal block is a common procedure for lower limbs surgery. Fentanyl is a synthetic opioid with central action, which is used widely for pain control. Intrathecal fentanyl is usually added to other local anesthetics to increase anesthesia and analgesia. It has improved spinal anesthesia and reduced the anesthetic drug related side effects including pruritus nausea and vomiting' and dexmedetomidine is a potent and highly selective a-2 adrenoceptor agonist with analgesic potency have been used in spinal anesthesia to prolong intraoperative and postoperative analgesia. However, here the researcher purposively, wanted to explore a double blind clinical trial between hyperbaric bupivacaine with fentanyl and hyperbaric bupivacaine with dexmedetomidine in spinal anesthesia for lower limb orthopedic surgery. The aim of this study was to observe and compare the onset & duration of motor & sensory block, hemodynamic effect, postoperative analgesia & adverse effect of each group.*

Material & Methods: *This was a randomized double blinded clinical trial. A total of 60 patients of both genders aged 18 to 50 years, American Society of Anaesthesiologist (ASA) physical status I and II who underwent lower limb orthopedic surgery were enrolled into the present study. Considering the sample size of 30 patients were selected for each group in our study. The patients received 15mg hyperbaric bupivacaine 0.5% plus 10 micrograms dexmedetomidine (Detomax) (BD group) & 25 micrograms fentanyl (Opifen) (BF group) respectively. Time to reach the highest sensory level, the complete motor block, regression from block, analgesic request and duration of the drug effect, hemodynamic changes and side effects were compared between the groups. Simple statistical tools were used to analyze the collected data and calculation. This present study was conducted in the Department of Anesthesiology at Kurmitola General Hospital, Dhaka, Bangladesh, during 1st July 2019 to 31stJanuary 2020.*

Results: *A total of 60 patients had selected during the study period.(Table I) shows the characteristics of the studied participants were comprising the primary analysis study population both groups had each 30 participants. Majority (56.67%) of cases was female and (43.33%) were male in the group BF and (36.67%) were male and (63.67%) were female in group BD. The age distribution of the studied participants majority (60%) were aged 18-40 years and 41-50 were (40.00%) in group BF. In group BD majority (66.67%) were 18-40 years and 41-50 were (33.33%). Sixty patients were randomly allocated to two groups of 30 patients.*

There was no significant difference between the groups in baseline findings.

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Time to reach the highest sensory level was shorter in BD group than BF group (6.33±1.69 vs 7.15±1.35, p=0.042). Time to reach complete motor block, there was no significant difference (p=0.171). Time to regress two sensory level(67.22±6.69 vs 87.98±11,98 min, p<0.001) and to regress S1(242.10±21.99 vs 330.10±43.98,p<0.001) between BF & BD Group. Group BD has longer duration to regress to Bromage 0 (P<0.001), to analgesic request (222.10±21.99 vs 295.98±45.10 min, p<0.001), and nonsignificant lower mean of NRS after six hours of operation (6.32±1.16 vs 6.17±1.43.p<0.657). There was no significant hemodynamic change between two groups and side effects were comparable. In two groups highest sensory block occurred in T6 dermatome (Table III). T5 dermatome was the second highest in BD group and T7 dermatome was second highest in BF group. We did not observe respiratory depression in any of the patient from either group.

Conclusion: *Hyperbaric bupivacaine with Dexmedetomidine is a superior anaesthesia technique alternate to hyperbaric bupivacaine with fentanyl in spinal anaesthesia for lower limb orthopaedic surgery.*

Key Words: *Anaesthesia, Bupivacaine, Fentanyl, Hyperbaric, Dexmedetomidine, Orthopedic Surgery.*

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INTRODUCTION:

One of the most important areas of anesthesia is postoperative pain management. Initial postoperative mobilization and rehabilitation with less pain and embarrassment is the most required quality that has been needed in modern orthopedic surgery.[1] Large volumes of local anesthetics were used to achieve this outcome, which also increase the opportunities of local anesthetic noxiousness and hemodynamic variability.[2] Neuraxial block is the preferred method in lower limb surgeries, although it could be performed under local, neuraxial and general anesthesia. Spinal block is cost effective and has deep block, fast onset, and lower risk of infection. However, post-operative pain is an important problem as the used drugs have limited duration of effect; so, the post-operative analgesic administration is necessary Managing the combinations of other types of analgesics with local anesthetics has used to increase the duration and diminish side effects of analgesia [3]. In spinal anesthesia, some drugs have been used as adjuvant to extend pre and post-operative analgesia such as opioids, α2 agonists, neostigmine, vasoconstrictors, etc. Dexmedetomidine is mostly used for anesthesia and analgesic purposes. This drug has sedative, anti-anxiety, analgesic, neuroprotective, and anesthetic effects 4. Meanwhile, fentanyl is a popular opioid as an adjuvant to bupivacaine to reduce the dose, to increase the inception and the duration of anaesthesia.[5] The improved specificity of dexmedetomidine for the α-2 receptor causes it to be much more effective sedative, anxiolytic, analgesic, antihypertensive, and sympatholytic properties with much lesser amount of unwanted cardiovascular effects.

Dexmedetomidine and fentanyl have been used as adjuvant to local anesthetics in several types of surgeries to offer higher analgesia and to advance the duration of the block[6-7]. One study on lower limbs surgery presented a better effectiveness with dexmedetomidine. The quality of perioperative anesthesia and analgesia is improved by dexmedetomidine.[8] .Fentanyl is hundred times more powerful than morphine and also works as an agonist at μ-opioid receptors to boost the analgesia, whereas, dexmedetomidine is a strong and highly selective α-2-adrenoceptor agonist.[9] Dexmedetomidine has a comparatively high ratio of α-2/α-1 activity (1620:1). Intrathecal fentanyl is usually added to other local anesthetics to upsurge anesthesia and analgesia. It has enhanced spinal anaesthesia and alleviate the anesthetic drug related side effects (such as- pruritus, nausea and vomiting)[10]. The aim of the present study was to compare the duration of effectiveness, quality, efficacy, hemodynamic stability and postoperative side effects between hyperbaric bupivacaine with fentanyl and hyperbaric bupivacaine with dexmedetomidine in spinal anesthesia for lower limb orthopedic surgery.

METHOD AND MATERIALS

This was a randomized double blind clinical trial. A total of 60 patients of either sex aged 18 to 50 years, American Society of Anaesthesiologist (ASA)physical status I and II who underwent lower limb orthopaedic surgery were enrolled into the present study. This study was conducted in the Department of Anesthesiology at Kurmitola General Hospital(KGH), Dhaka, Bangladesh during 1st July 2019 to 31st January 2020. The Ethical Committee approved this study and written informed consent was obtained from all subjects before inclusion in the study. The patients were randomly allocated to two groups. The patients of group (BF) received 15mg hyperbaric bupivacaine 0.5% with 25 micrograms fentanyl and (BD) group received 15mg hyperbaric bupivacaine with 10 micrograms dexmedetomidine. All patients were kept for 6 hours fasting prior to surgery. Preloading completed with Ringer lactate salutation (10 ml/kg body weight).Standard monitoring including non-invasive blood pressure (NIBP), ECG, heart rate and pulse oximetry performed. All patients received supplemental oxygen via mask (5 l/min). Under proper aseptic conditions, the selected anaesthesia was given at the level of L4-L5 interspace in sitting position using a midline or paramedian approach by a 25 G Quincke spinal needle. The anesthetic medication is injected at a rate of appropriately 0.2 ml/ sec and then all patients were made supine. We recorded systolic and diastolic blood pressure and heart rate after and before insertion of the selected anaesthesia groups. in the 1, 3, 5, 10, 20, 30, and 60 minutes. Postoperative pain was assessed using Numerical Rating Scale (NRS) at 6, 12, 18, 24 hrs. All data were recorded in a data sheet specified to each patient. As we needed anesthetic effects, both sensory and motor status were assessed prior to the spinal injection,then every 2 min after injection until reaching the highest sensory level and Bromage scale reaching to Bromage 3. After surgery assessment performed every 10 min until the time to regression of 2 sensory levels, then every 20 min until the regression time to the dermatome S1 and motor scale to Bromage 0. The motor block was assessed according to the Bromage scale: Bromage 0 (None): Free movement of legs and feet. Bromage I (Partial):Just able to flex knees with free movement of feet. Bromage II (Almost complete): Unable to flex knees, but with free movement of feet. Bromage III (Complete):Unable to move legs or feet. Severity of pain 6 hours after surgery was measured by Numeric Rating Scale(NRS).The patients were asked to rate their pain from a scale of 0=no pain to 10= the worst possible pain. In case of any side effects it was recorded. also The data were analyzed using simple statistical tools.The results were expressed as Mean ±SD or percentage. The nominal categorical data between study groups were compared by using the chi- squared test. P-values < 0.05 were considered statistically significant.

- **Inclusion Criteria**
  - Patients satisfying ASA physical status Class I and II who were undergoing lower limb orthopaedic surgery.
  - Patients with age between 18 and 50 years of either sex.
- **Exclusion Criteria**
  - Patients undergoing emergency surgeries, deformities of the spine, hypersensitivity to any of the drugs in the study.

RESULT

A total of 60 patients had selected during the study period.(Table I) shows the characteristics of the studied participants were comprising the primary analysis study population both groups had each 30 participants. Majority (56.67%) of cases was female and (43.33%) were male in the group BF and (36.67%) were male and (63.67%) were female in group BD. The age distribution of the studied participants majority (60%) were aged 18-40 years and 41-50 were (40.00%) in group BF. In group BD majority (66.67%) were 18-40 years and 41-50 were (33.33%). Sixty patients were randomly allocated to two groups of 30 patients. There was no significant difference between the groups in baseline findings. Time to reach the highest sensory level was shorter in BD group than BF group(6.33±1.69 vs 7.15±1.35, p=0.042). Time to reach complete motor block, there was no significant difference (p=0.171).

Time to regress two sensory level(67.22±6.69 vs 87.98±11,98 min, p<0.001) and to regress S1(242.10±21.99 vs 330.10±43.98,p<0.001) between BF & BD Group. Group BD has longer duration to regress to Bromage 0 (P<0.001), to analgesic request (222.10±21.99 vs 295.98±45.10 min, p<0.001), and non-significant lower mean of NRS after six hours of operation (6.32±1.16 vs 6.17±1.43.p<0.657). There was no significant haemodynamic change between two groups and side effects were comparable. In two groups highest sensory block occurred in T6 dermatome (Table III). T5 dermatome was the second highest in BD group and T7 dermatome was second highest in BF group. We did not observe respiratory depression in any of the patient from either group.

Table I: Baseline findings of the studied population. (n=60).

Age and Sex	**Hyperbaric bupivacaine with fentanyl** group(BF) **(n=30)**	**%**	**Hyperbaric bupivacaine with dexmedetomidine** group(BD) **(n=30)**	**%**
Sex				
Male	13	43.33	11	36.67
Female	17	56.67	19	63.33
Age (years)				
18-40	18	60.00	20	66.67
41-50	12	40.00	10	33.33
BMI	25 ±3			

Table II: Characteristics of block between the two groups. (n=60) .

Variable	BF(n=30) Mean+SD	BD(n=30) Mean+SD	P-Value
Time from injection to highest sensory level (min)	7.15±1.35	6.33±1.69	0.042
Time of two segment regression from the highest sensory level(min)	67.22±6.69	87.98±11.98	<0.001
Time for sensory regression to S1 from highest sensory level (min)	242.10±21.28	330.10±43.98	<0.001
Onset to Bromage 3 (min)	556±165	506±180	0.171
Regression to Bromage 0 (min)	146.98±34.04	184.99±36.10	<0.001
Time to rescue analgesia(min)	222.10±21.99	295.98±45.10	<0.001
NRS six hours after surgery	6.32±1.16	6.17±1.43	0.657

Table III: Highest dermatome level of sensory block

Variable	BF(n=30)	%	BD(n=30)	%
T4	0	0	01	3.33
T5	05	16.66	06	20.00

T6	11	36.66	18	60.00
T7	10	33.33	02	6.66
T8	04	13.33	03	10.00

Table-IV: Mean heart rate at different times points among the study participants. (n=60)

Heart rate at different time points	BF	BD
	Mean +SD	mean + SD
Before SAB	89.10 ± 5.55	90.15± 5.51
1 minute after SAB	103.10 ± 6.57	101.15± 6.48
3 minutes after SAB	105.40 ± 6.90	102.73 ± 6.65
5 minutes after SAB	100.70±4.49	97.45 ±7.05
10 minutes after SAB	95.91 ±5.25	93.14 ±5.33
20 minutes after SAB	90.74 ± 5.10	88.41 ± 6.92
30 minutes after SAB	81.18± 4.17	80.48±5.29
60 minutes after SAB	70.68± 4.70	75.39±4.82

Table-V: Mean systolic blood pressure at different times points among the study participants. (n=60)

Systolic blood pressure at different times points	BF	BD
	Mean +SD	mean + SD
Before SAB	131.10 ± 1.45	131.05± 1.62
1 minute after SAB	116.20 ± 4.98	120.10 ± 3.21
3 minutes after SAB	113.96 ± 1.66	117.20 ± 3.05
5 minutes after SAB	111.10 ± 3.56	114.06 ±6.81
10 minutes after SAB	110.63 ±4.62	112.53 ±4.33
20 minutes after SAB	116.20 ± 8.29	116.98 ±5.15
30 minutes after SAB	116.15±5.17	115.56 ±4.99
60 minutes after SAB	120.38±3.78	120.17 ±4.61

Table -VI: Mean diastolic blood pressure at different times among the study participants.(n=60)

Diastolic blood pressure at different time points	BF	BD
	Mean +SD	mean + SD
Before SAB	79.58 ± 2.60	80.21± 2. 75
1 minute after SAB	71.00 ± 5.60	75.96 ± 5.45
3 minutes after SAB	70.44 ± 4.92	70.98 ± 5.53
5 minutes after SAB	60.10± 3.51	60.92 ± 4.55

10 minutes after SAB	55.20 ±2.31	65.98 ± 3.56
20 minutes after SAB	60.71 ± 2.51	70.73 ±3.14
30 minutes after SAB	65.61±2.33	73.58 ±3,10
60 minutes after SAB	76.58± 2.29	75.49 ± 2.69

Table VII: Side effects between two groups. (n=60).

Variables	Group BF (n=30)	%	Group BD (n=30)	%
Nausea	02	6.66	01	3.33
Vomiting	01	3.33	00	00
Shivering	04	13.33	01	3.33
Headache	03	10.00	02	6.66
Dizziness	02	6.67	03	10.00
Urinary retention	03	10.00	02	6,66
Dry mouth	06	20.00	04	13.33
Pruritus	03	10.00	00	00

DISCUSSION

In our study we divided the total patients in two groups where we included dexmedetomidine treated patients in BD group and fentanyl treated patients in BF group. Group BD showed better reduction in postoperative NRS

at six hours after surgery than group BF. Soliman and Eltaweel evaluated the addition of dexmedetomidine and fentanyl in a study as an adjuvant to bupivacaine in patients undergoing total knee replacement surgeries which is quite similar to our study. They found that dexmedetomidine provides a superior postoperative analgesia and decreases the postoperative narcotics requirements.[11] Dexmedetomidine has efficient analgesia and lengthy motor recovery as an adjuvant to bupivacaine in epidural block for lower limb and lower abdominal surgeries when blockade compared to fentanyl as an adjuvant. Epidural anaesthesia with catheter insertion for lower abdominal surgeries are found to avoid the stress of general analgesia, are useful for prolonged surgeries and useful to relief from postoperative pain.[12] The reduction in the heart rate affected by α-2 agonists can be clarified on the basis of their central action where they decrease the sympathetic outflow and norepinephrine release.[13] Eskandar et al. found that the heart rate reduced significantly, but the reduction in mean arterial pressure is not significant in dexmedetomidine group.[14] After adding dexmedetomidine as an adjuvant to ropivacaine compared to the control group Bajwa et al. found no significant changes in the heart rate and blood pressure and the same result was shown by other studies.[15] The sedative effect of dexmedetomidine is probably mediated by the stimulation of presynaptic α-2 adreno receptors in the locus coeruleus, leading to inhibition of release of norepinephrine, along with it, inhibition of adenylate cyclase may lead to hypnotic response.[16] In our study we found, the comparative incidence of various side effects in both the groups which were observed in the intra-operative and post-operative period. Nausea (40.00%), vomiting (16.67%), shivering (6.67%), Dry mouth (13.33%) were observed to a significant level in the BD group. The incidence of dry mouth was notably higher in the BF (20%) group as compared to the BD (13%) group. The incidence of other side effects like headache, shivering was similar but dizziness and urinary retention were comparable in both the groups. We did not witness respiratory depression in any of the patient from either group. Avoidance of respiratory depression in the patients who were administered dexmedetomidine was one of the most remarkable observations and the evidence is similar to the earlier studies where researchers have found complete absence of clinically detectable respiratory depression in the previous multiple human studies.[17-18]

LIMITATIONS OF THE STUDY

This was a prospective double blinded clinical trial study in a single community with comparatively small number of sample size. So,

the study result may not reflect the exact scenarios of the whole populations.

CONCLUSION AND RECOMMENDATIONS

Hyperbaric bupivacaine with dexmedetomidine is accompanying with quicker onset of and prolonged sensory and motor blockade with lesser obligation of rescue analgesia associated to bupivacaine with fentanyl. We conclude that dexmedetomidine as an adjuvant to hyperbaric bupivacaine is a better alternative to fentanyl with hyperbaric bupivacaine as it shows faster onset of sensory block, lesser time to attain maximum sensory level, prolonged duration of analgesia, and longer motor blockade with higher sedative property.

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