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Effect of Addition of Dexmedetomidine to Ropivacaine in Lumbar Plexus Block for Post Operative Pain Management in Neck of Femur Fracture

Megha Arora[1], Venus Sharma[2], Lalit Wadhawan[3]

[1,2,3]Senior Resident, Department of Anesthesiology, SMS Medical College and Hospital, Jaipur, Rajasthan 302004, India

Abstract

Introduction: The incidence of femoral neck fractures, one of the most common traumatic injuries in elderly patients increases continuously among the ageing population. Anaesthetic management of NOF is either spinal or general anaesthesia. One of the modalities for postoperative pain control is lower limb peripheral nerve blocks. Opioids like fentanyl, tramadol, midazolam, neostigmine, clonidine and dexmedetomidine are being used. Dexmedetomidine has been used as an adjuvant in local anaesthetic solutions at a dose of 1 μg/kg in lumbar plexus block and has convincingly shown to prolong the duration of anaesthesia and post-operative analgesia. Despite these assumptions, an understanding of the mechanism and site of the action of dexmedetomidine used as an adjuvant to lumbar plexus block is unknown. Hence, this study was conducted with Aim of: (1) The effectivity of dexmedetomedine as an adjuvant to Ropivacaine 0.75% in lumbar plexus block. (2) To study the adverse effects of dexmedetomidine in lumbar plexus block. *Methods:* This is a prospective, double blind randomised systemic control trial. It comprises of three groups. Lumbar plexus block was given using Inmed (R) nerve stimulator using a 100-mm-long stimulating needle. Capdevila is the current technique of choice. *Results:* The mean age and sex in Group A (d) (Study Group), Group B (ivd) (Control Group) and Group C (r) (Placebo Group) are similar. Surgery lasted for 40 to 60 minutes. All three groups were statistically comparable. Mean duration of sensory block was 586 ± 37.77 min (group A), 390 ± 24.91 min in (group B) and 376.83 ± 26.79 min (group C). The prolongation of sensory block was highly significant in group A when compared to group B and C. Mean VAS score at 6 hrs in Group A was 1.37 ± 0.60, Group B 1.67 ± 0.76 and in Group C 1.87 ± 0.82. No complications due to the block or drugs used. *Conclusion*: Dexmedetomidine at the dose of 1 mcg/kg can be added to 0.75% ropivacaine, perineurally in lumbar plexus block effectively and safely.

Keywords: Dexmedetomidine; Ropivacaine; Lumbar Plexus Block; Neck of Femur Fracture.

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Introduction

The incidence of femoral neck fractures, one of the most common traumatic injuries in elderly patients increases continuously among the ageing population. According to more recent research [1], half of the proximal femur fractures are intraarticular fractures of the femoral neck. The incidence increases with age, and after 50 years is doubled for each subsequent decade, and is

Corresponding Author: Megha Arora, Senior Resident, Department of Anesthesiology, SMS Medical College and Hospital, Jaipur, Rajasthan 302004, India

E-mail: sbapna.1@gmail.com

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2-3 times higher in women than in men. Most of the hip fractures occur after a fall.

Anaesthetic management of NOF is either spinal or general anaesthesia, however effective postoperative pain control is a challenge to which answers are still being sought. One of the modalities for postoperative pain control is lower limb peripheral nerve blocks like lumbar plexus block, sciatic nerve block and sacral plexus block. It is principally used for post-operative analgesia for major orthopaedic surgery of the hip, femur and knee. Certain drugs may be used as adjuvant to local anaesthetics to lower doses of each agent and enhance analgesic efficacy and prolong the post operative pain relief, while reducing the incidence of adverse reactions.

Conventional adjuvants are adrenaline which delays LA absorption from the site and sodium bicarbonate which helps in spread of local anaesthetic solution in neural sheath more effectively. Current adjuvants [2] being studied are:

Opioids – fentanyl, tramadol, Magnesium sulfate, Dexamethasone, Midazolam, Neostigmine, α_2-receptor agonists, clonidine and dexmedetomidine.

Dexmedetomidine [3] is a selective α_2-receptor agonist used commonly as a centrally acting antihypertensive. Dexmedetomidine is a lipophylic a-methylol derivative has higher affinity and more selective to α2 receptor. It has sedative, analgesic, sympatholytic effect that blunt many of the cardiovascular response seen during perioperative period.

Dexmedetomidine has been used in as an adjuvant in local anaesthetic solutions at a dose of 1 µg/kg in lumbar plexus block and has convincingly shown to prolong the duration of anaesthesia and post-operative analgesia. Despite these assumptions, an understanding of the mechanism and site of the action of dexmedetomidine used as an adjuvant to lumbar plexus block is unknown. But the effect of dexmedetomidine was shown to be likely due to blockade of hyperpolarisation-activated cation current.

Hence, this study was conducted to find out if dexmedetomidine work as well through intravenous route as in a mixture with Local Anaesthetic solution in lumbar plexus block, and with as minimal side effects. Therefore, this study was designed with intravenously administered dexmedetomidine (systemic control) arm in addition to the study and placebo group. Local Anaesthetic used in this study was ropivacaine. 0.75% Ropivacaine is a long-acting amide local anaesthetic agent and first produced as a pure enantiomer.

Aims and Objectives

1. To evaluate the effectivity of dexmedetomedine as an adjuvant to Ropivacaine 0.75% in lumbar plexus block.
2. To study the adverse effects of dexmedetomidine in lumbar plexus block.

Material and Methods

This is a prospective, double blind randomised systemic control trial. It comprises of three groups, namely:

Group A(d) (Study Group): lumbar plexus block with ropivacaine 0.75% 20 ml + dexmedetomidine 1 mcg/kg + IV Saline 5 ml.

Group B (ivd) (Control Group): lumbar plexus block with ropivacaine 0.75% 20 ml + IV dexmedetomidine 1 mcg/kg + IV saline qs 5 ml.

Group C (r) (Placebo Group): lumbar plexus block with ropivacaine 0.75% 20 ml + IV saline 5 ml.

Technique

Lumbar plexus block was given using Inmed(R) nerve stimulator using a 100-mm-long stimulating needle (Stimuplex(R), B-Braun(R) Germany). Posterior approach is used now-a-days. Capdevila is the current technique of choice. There are several posterior landmark based approaches to the lumbar plexus [4] all of which require the patient to be in the lateral position with the operative side uppermost, the hips and knees are flexed to 90 degrees; The spinous process of L4 is identified. A line was drawn from the centre of the L4 was spinous process laterally, to intersect with a line that passes through the posterior superior iliac spine parallel to the vertebral column on the side to be blocked. The puncture point is at the junction of the lateral one third and medial two thirds of the line joining L4 to the line passing through the PSIS. The needle was advanced at right angles to the skin until the transverse process of L4 was encountered. The needle was then directed caudally, no more than 20 mm.

The nerve stimulator was set initially at 1.0 to 1.2 mA, and we looked for a quadriceps muscle twitch (femoral nerve) when the needle got proximal to the lumbar plexus (this twitch is usually

encountered at a depth of 5 to 8 cm from the skin). Needle was inserted with a slight medial angulation to the sagittal plane of the patient making small adjustments of the needle tip caudad and cephalad. Once contact with the transverse process of L4 was obtained, bring the needle back towards the skin, redirecting it caudally to "walk off" the process. The plexus was stimulated at a depth of no more than 2 cm beyond the transverse process; beyond this the risk of injury to retroperitoneal structures would increase. On decreasing the stimulator current to 0.5 mA, if the twitch remains evident with the decreased current, local anaesthetic was incrementally injected after negative aspiration.

Then central neuraxial block was administered to allow the surgery to proceed. Anatomic landmarks for the desired level of the block was first identified. Superior Iliaccrests was palpated and L4 identified. The spine was palpated to ensure spine position with relation to the plane of the floor.

A sterile field was established with povidone-iodine applied with three basic sponges, the solution was applied starting from the injection site moving outward in a circular fashion.

A fenestrated drape was applied, and using a sterile gauze, wipe the iodine from the injection site to avoid initiation into the subarachnoid space. A 25G spinal needle was inserted into the introducer, passing through the epidural space, dura, and arachnoid to the sub arachnoid space stopping when the presence of CSF is determined.

CSF aspirated and mixing lines were identified as a change in baricity and temperature as the local anaesthetic and CSF mix in the syringe.

The following observation was made in the postoperative period at 0 min/30min/2hr & every 4 hr upto 24 hrs.

Following outcome assessment

- Sensory block was graded as-

Grade 0: Sharp pain felt

Grade 1: Analgesia, dull sensation felt

Grade 3: Anaesthesia, no sensation felt.

- Motor block Assessment – Bromage Scale [5].

Degrees	Evidence
0	Full leg movement, full flexion of knees and ankles
1	Inability to raise extended legs, just able to flex knees, full ankle flexion
2	Inability to flex knees, some flexion of ankles possible
3	No movement possible (unable to move legs or feet)

Postoperatively, this testing was done every 30 mins until the sensory and motor variables become normal. Postoperatively quality of analgesia would be evaluated with visual analogue scale from 0 to 10 where 0 defines no pain and 10 defines worst pain ever suffered, every 30 min until VAS > 5. Supplementary analgesia would be given at VAS > 5.

Observation and Results

Table 1: Mean Duration of Sensory Block

	Duration (min)	p value		Remarks
Group A (d)	586.67 ± 31.77	A/B	<0.001	H. Significant
Group B (ivd)	390.00 ± 24.91	A/C	<0.001	H. Significant
Group C (r)	376.83 ± 26.79	B/C	0.06	N. Significant

Table 1 shows mean duration of sensory block in Group A (d) 586.67 ± 31.77 min, Group B (ivd) 390.00 ± 24.91 min, Group C (r) 376.83 ± 26.79 min. When the difference in sensory block between group A vs B and group A vs C compared are highly significant, but there was no statistically significant difference between group B vs C.

Fig 1 shows the mean duration of motor block in Group A (d) 628.33 ± 32.06 (min), Group B (ivd) 426.67 ± 24.82 (min), Group C (r) 416.00 ± 27.93 (min). When difference in motor between group A/B & A/C compared, they are highly significant. Whereas there was no statistically significant difference on motor block between group B/C.

Fig. 2 shows duration of analgesia in Group A (d) was 852.50 ± 42.72 min, Group B (ivd) 750.77 ± 34.75 min, Group C (r) 668.57 ± 45.38 min. The difference in duration of analgesia in group A vs B & A vs C, B vs C was highly significant.

Table 2 shows demonstrate that mean VAS score in 24 hr was less than 4 throughout the study period showing good post operative analgesia. Overall VAS at 12 hr was significantly higher in group C than b & A. Thus VAS was group A<B<C.

Fig. 3 shows 100 mg iv tramadol was given to the patient when they complained of pain. Above observations shows mean tramadol consumption in Group A (d) 13.33, Group B (ivd) 43.33, Group C (r) 46.66.

Only 4 patients had bradycardia, 2 patients had hypotension in Group A (d) whereas 2 patients had hypotension & bradycardia in Group B (ivd) while none of the patients had either in Group C (r). When Group A, B, C were statistically compared, results were not significant. Bradycardia was treated by 0.6 mg atropine iv and Hypotension was treated by

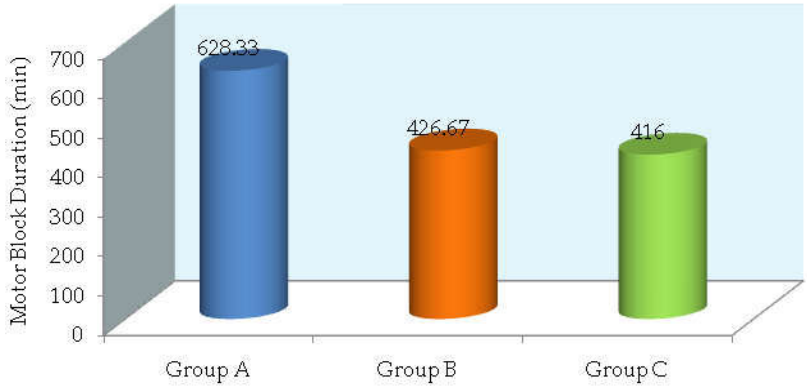

Fig. 1: Mean duration of motor block

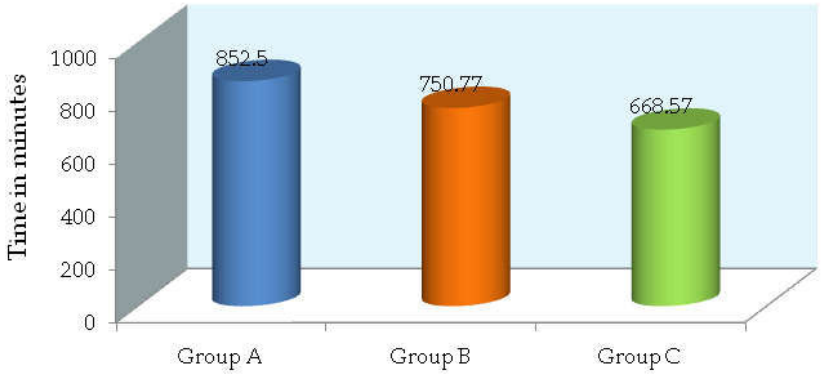

Fig. 2: Mean Duration of Analgesia in mins (Time of Request of 1st Dose of Analgesia)

Table 2: Mean VAS Score

Time (in hrs)	Group			p value		
	Group A (d)	Group B (ivd)	Group C (r)	Group A/B	Group A/C	Group B/C
1	0	0	0	-	-	-
6	1.37 ± 0.60	1.67 ± 0.76	1.87 ± 0.82	0.09	0.009	0.33
12	1.37 ± 0.61	2.93 ± 0.45	3.40 ± 0.62	<0.001	<0.001	<0.001
24	3.13 ±0.50	3.27 ± 0.35	3.30 ± 0.00	0.62	0.539	0.877

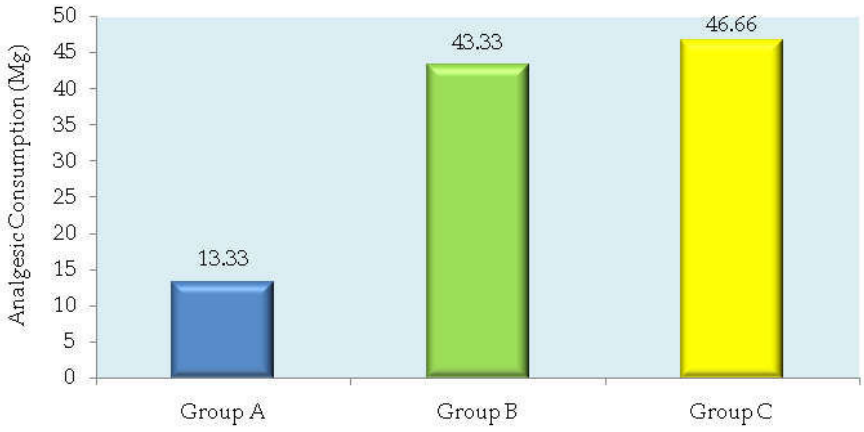

Fig. 3: Analgesic Consumption

Table 4: Hemodynamic Variables (Mean Heart Rate)

Heart Rate	Group			p value		
	Group A (d)	Group B (ivd)	Group C (r)	Group A/B	Group A/C	Group B/C
0 min	86.47 ± 11.66	81.00 ± 13.79	88.97 ± 5.36	0.103	0.291	0.005
5 min	80.80 ± 13.55	78.30 ± 10.26	83.97 ± 6.25	0.424	0.250	0.012
10 min	79.37 ± 15.88	76.87 ± 8.99	79.43 ± 7.11	0.456	0.983	0.225
15 min	76.23 ± 14.12	76.37 ± 8.32	75.60 ± 8.27	0.965	0.833	0.722
30 min	79.37 ± 9.80	77.73 ± 8.35	73.87 ± 5.59	0.490	0.010	0.039
60 min	79.47 ± 9.45	79.47 ± 8.17	76.40 ± 5.30	1.000	0.127	0.090

Table 5: Hemodynamic Variables (MBP)

MBP	Group			p value		
	Group A (d)	Group B (ivd)	Group C (r)	Group A/B	Group A/C	Group B/C
0 min	105.25 ± 10.69	104.15 ± 12.94	104.23 ± 11.07	0.721	0.719	0.979
5 min	99.00 ± 9.46	98.07 ± 10.40	102.03 ± 10.28	0.718	0.239	0.143
10 min	96.33 ± 10.77	97.47 ± 7.45	102.52 ± 8.62	0.637	0.017	0.018
15 min	96.50 ± 9.94	97.10 ± 6.55	101.87 ± 7.47	0.784	0.021	0.011
30 min	98.95 ± 8.70	96.77 ± 6.03	103.32 ± 6.74	0.263	0.034	0.000
60 min	103.18 ± 8.00	101.02 ± 6.60	103.80 ± 7.22	0.257	0.755	0.125

6 mg iv bolus mephertamine.

Table 4 and 5: demonstrates that there was statistically significant bradycardia/hypotension at 10, 15, 30 minutes in Group A, B, C (p value <0.05). But this was not clinically significant.

Discussion

The mean age in Group A (d) 44.87 ± 16.95, Group B (ivd) 49.50 ± 14.69, Group C (r) 50.80 ± 16.69. Sex distribution was similar in all the three groups. There were 53.33% males and 46.67% females in Group A (d), 73.33% males and 26.67% females in Group B (ivd), 56.67% males and 43.33% females in Group C (r). Duration of surgery - majority of surgery lasted for 40 to 60 minutes. All three groups were statistically comparable. Mean duration of surgery in Group A (d) 56.67 ± 14.87, Group B (ivd) 56.00 ± 8.55, Group C (r) 55.83 ± 10.59.

In the present study mean duration of sensory block in patients who received perineural dexmedetomidine was 586 ± 37.77 min (Group A). While it was 390 ± 24.91 min in patients who received iv dexmedetomidine (Group B) and 376.83 ± 26.79 min in control group (Group C). The prolongation of sensory block was highly significant in group A when compared to group B and group C.

The prolongation of sensory blockade was also accompanied by a prolongation in duration of analgesia in group A (852 ± 42.72) min when compared with group B and group C (750.77 ± 34.75) min and (668.57 ± 45.38) min respectively; (p vlue 0.001). There was also a significantly longer duration of analgesia in group B when compared to Group C (p value 0.001) which is strongly suggestive of the systemic action of analgesia by dexmedetomidine.

Zang et al. (2014) [6] reported prolongation of sensory block in patients who received 50 mcg of dexmedetomidine in 40 ml of 0.33% Ropivacaine when compared to patients with Ropivacaine alone in axillary Brachial plexus Block. The duration of analgesia in their study was also greater in patients who received perineural /intravenous dexmedetomidine when compared to patients who received Ropivacaine alone. These results are similar to the findings of our study and by Soliman et al. (2015) [7] and Helal et al. (2016) [8].

Duration of sensory block in group B was 412.50 ± 54.26 (min), group BD 594.67 ± 104.69 (p value <0.001). Duration of motor block in Group B was 247 ± 39 mins; Group BD 335 ± 38.54 mins. Duration of sensory motor block was longer in Group BD than Group B (Bupivacaine) p<0.01. Duration of analgesia in group B was 462.50 ± 54.26 and group BD 807.67 ± 112.85 mins (p value <0.001).

Indira Gujrala et al. (2017) [9] assessed the influence of addition of 50 mcg dexmedetomidine to 35 ml of 0.5% ropivacaine on the characteristic of supraclavicular Brachial plexus block and

its interaction with General Anesthesia. They reported that the duration of analgesia, sensory, and motor blockade were significantly prolonged in patients who received Dexmedetomidine along with Ropivacaine and than in those who received Ropivacaine alone.

A large meta analysis conducted by L. Voro beichik et al. (2017) [10] has compelling evidence indicating that perineural dexmedetomidine improves Brachial plexus Block onset, quality and analgesia when added to local anesthetic. They found that dexmedetomidine prolong sensory blockade (at least 57%, p value <0.001), motor blockade (at least 58% p value <0.001) and mean analgesia (at least 63% p value <0.001). Dexmedetomidine also reduces post operative oral morphine consumption, improves pain control and enhanced patient satisfaction.

Although ultrasound guidance has added value to the localisation of lumbar plexus, its deep anatomical location is a hindrance to effective ultrasound Visualisation. The use of nerve stimulation is widely accepted method of localisation of lumbar plexus.

As the block involves the deposition of large volume of local anaesthetic within the belly of highly vascular psoas muscle, we used ropivacaine to minimise the chances of inadvertent toxicity of LA.

In the present study, mean VAS score at 6 hrs in all the three groups was Group A (d) 1.37 ± 0.60, Group B (ivd) 1.67 ± 0.76 and Group C (r) 1.87 ± 0.82. Mean VAS at 12 hrs in different groups was Group A (d) 1.37 ± 0.61, Group B ivd 2.93±0.45 and Group C (r) 3.40 ± 0.62. This difference was statistically significant (p value <0. 001). This difference showed superior quality of sensory block and analgesia by addition of dexmedetomidine to ropivacaine perineurally. However no significant difference in VAS scores in Group A (d), Group B (ivd) and Group C (r) (3.13 ± 0.50, 3.27 ± 0.35, 3.30 ± 0.00) at 24 hrs was found. This showed that most of the patients who had pain received analgesia latest by 15 hrs hence VAS at 24 hrs did not measure quality of block alone and was a reflection of the systemic analgesic received also.

Similar findings regarding VAS and decrease in post operative analgesic requirement was shown by Soliman et al [7]. They studied the effect of addition of dexmedetomidine to bupivacaine for postoperative analgesia in lumbar plexus block among hip arthroplasty patients. Total consumed morphine in the first 24h was less among group BD patients compared with those in group B (19 vs. 32 mg; p < 0.001). As regards the VAS, it was significantly lower in group BD than group B in the first 8h postoperatively (p < 0.001). Similarly Stevens et al. [11] described Lumbar plexus block reduces pain and blood loss associated with Total Hip Arthroplasty. They showed that there was significant lower pain scores at 6 hours after total hip arthroplasty in patients receiving a single-injection posterior lumbar plexus block combined with general anesthesia, compared with patients who did not receive a PCB (VAS at 6 Hr 1.4 ± 1.3 versus 2.4 ± 1.4, p value =0.007). There was reduced consumption of morphine as rescue analgesia postoperatively at 12 hr. Only 2 of 28 out of plexus group require rescue morphine than 22 of 29 among controls (p<0.0001).

As in this study we are placing spinal anesthesia immediately after giving block and the surgery was carried out under SAB. It was difficult to rule out that hemodynamic changes were due to administration of Lumbar plexus block (LPB) or SAB. The incidence of bradycardia and hypotension was more in group A which was given perineural dexmedetomidine as compared to group B and C at 30 and 60 min (p value <0.01) which was statistically significant. But this was not clinically significant. Thus dexmedetomidine causes more bradycardia hypotension when given perineurally than intravenously.

Amiri and Zamani et al. (2014) [12] showed no evidence of abrupt and intense variation in HR, systolic and diastolic BP, and mean arterial pressure during LPB. The hemodynamic stability in the elderly patients is of great importance; therefore, according to the study by Ho et al. and Asao et al. [13], LPB can be suggested as the first choice in the elderly, critically ill, hemodynamically compromise patients, Aortic stenosis and heart failure patients.

Soliman et al. [7] studied the effect of addition of Dexmedetomidine to Bupivacaine in Lumbar plexus block in Hip arthroplasties on hemodynamics. Regarding hemodynamic changes, there was significant decrease in HR starting 120 min post induction to 4 h postoperatively within group BD (Bupivacaine and Dexmedetomidine) compared with group B (Plain Bupivacaine) (p <0.001). But no clinically significant changes observed.

No complications due to the block or drugs used were noted in our study.

Conclusion

There is a significant increase in the duration

of sensory and motor blockade achieved by lumbar plexus block when dexmdetomidine is added perineurally to 20 ml of 0.75% ropivacaine than plain ropivacaine or when an equal dose of dexmedetomidine given intravenously. There was no major adverse effect related to the drug used observed. Therefore dexmedetomidine at the dose of 1 mcg/kg can be added to 0.75% ropivacaine, perineurally in lumbar plexus block effectively and safely.

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