Original article:

Unilateral Spinal Anaesthesia for Knee Arthroscopy: A Randomised Controlled Trial of Hyperbaric Solutions of Ropivacaine Alone and Clonidine and Fentanyl as Adjuvants

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Abstract

Objectives: To evaluate the clinical effects of hyperbaric ropivacaine alone and with clonidine or fentanyl for spinal anaesthesia for knee arthroscopy.

Methods: Sixty ASA I/II patients were randomised to receive spinal anaesthesia with hyperbaric ropivacaine alone (Group R), or with clonidine 15 µg (Group RC) or fentanyl 30 µg (Group RF). The sensory and motor block, time to micturition and side effects were assessed.

Results: The three groups were similar in mean time to onset of sensory block at T10, height of block and time to maximum block. Sensory regression to S2 took longer in Groups RF and RC compared with Group R ($p = 0.001$ and $p<0.01$ respectively.Time to requirement of rescue analgesia was longer in Groups RF and RC compared with Group R ($p = 0.023$ and 0.002, respectively). Time for complete regression of motor block and time to voiding were longer in group RC compared with group R ($p = 0.022$ and $p = 0.013$, respectively)

Conclusion: The addition of fentanyl 30 µg to hyperbaric ropivacaine may be superior to the addition of clonidine 15 µg for knee arthroscopy as it provides a similar prolongation of sensory block and analgesia without prolonging motor block and time to micturition.

Keywords:Unilateral Spinal Anaesthesia, Ropivacaine, Clonidine, Fentanyl, adjuvants

Introduction

Arthroscopic procedures for knee are increasingly performed as ambulatory procedures. Appropriate anaesthetic technique is required for an uncomplicated recovery with minimal pain.Spinal anaesthesia is a simple and quick procedure with a short turnover time and provides good surgical conditions. It is a reliable, safe and cheap technique with minimal side effects. The most important factors in detern1ining discharge time are pain, nausea and vomiting, unresolved neuraxial blocks & urinary retention. In day care surgery it is desirable that motor block regression is fast, to allow patients to walk safely and avoid urinary retention; but spinal anaesthesia is associated with unpredictable onset & regression of blockade, urinary retention, transient neurologic symptoms (TNS).

Ropivacaine is the pure S enantiomer of propivacaine and is a long acting amide local anaesthetic. It appears to be associated with a lower incidence or grade of motor block than bupivacaine and has a reduced potential for CNS toxicity and cardiotoxicity. Ropivacaine is well tolerated after intrathecal use, and has been found to have a shorter duration of action than bupivacaine, making it a possible alternative to lidocaine because of the low incidence ofTNS.[2]

The dose of longer-acting local anaesthetics can be reduced by combining them with adjuvants like

opioids and □2-adrenergic agonists. Small doses of clonidine and fentanyl have been shown to be effective in intensifying spinal anaesthesia. Clonidine does not induce pruritus or respiratory depression, which are common side-effects when opioids are used.[1]

Subarachnoid fentanyl is known to provide rapid onset of analgesia, improve surgical blockade quality and enhance the effect of small doses of subarachnoid bupivacaine.[3] The success rate of spinal anaesthesia can be further optimized by restricting the block to the operative site. Unilateral spinal anaesthesia diminishes the risk of hypotension during anaesthesia, enables faster recovery and results in increased patient satisfaction.

Material & Methods

This prospective randomized double blind study was conducted on 60 patients of age 18-60 years undergoing knee arthroscopy Written and informed consent was taken. Ethical comitee permission taken.

Exclusion criteria were Allergy-to local anaesthetics, clonidine and opioids. Inability to comply with study procedure i.e. psychiatric disorder, language problem etc.and BMI >30..

ALLOCATION OF GROUPS:

The 60 patients were randomly allocated to one of the three study groups according to a computer generated randomization table:

Group R: Patients received intrathecal spinal anaesthesia with 15 mg hyperbaric ropivacaine (2 ml of0.75% ropivacaineand.0.4 ml of 50% dextrose).

Group RC: Patients received intrathecal spinal anaesthesia with 15 mg hyperbaric ropivacaine concomitantly with 15 □g clonidine (2 ml of 0.75% ropivacaine and 0.4 ml 50% dextrose and 0.1 ml preservative free clonidine).

Group RF: Patients received intrathecal spinal anaesthesia with 15 mg hyperbaric ropivacaine concomitantly with 30 □g fentanyl (2 ml of 0.75% ropivacaine and 0.4 ml of 50% dextrose and 0.6 ml fentanyl)

(Ropivacaine: Ropin 0.75% Neon laboratories limited, preservative free).

All study solutions were prepared aseptically in identical syringes and the volume made upto 3 ml using sterile nom1al saline in all the 3 groups by an anaesthesiologist not involved with subsequent administration and patient assessment. The investigator was blinded as to the identity of the solution. All solutions were administered at room temperature. All study medications were procured from the hospital pharmacy.

All patients included in the study received tab midazolam 7.5 mg orally 1 hour before being shifted to OT. In the OT standard intra-operative monitoring was instituted comprising of ECG, pulse oximetry and NIBP. An 18 gauge iv cannula was inserted in a suitable peripheral vein and an infusion of 500 ml of Ringers lactate was commenced. All patients received 75 mg diclofenac by iv infusion prior to commencement of surgery. Baseline values of heart rate and blood pressure were noted prior to positioning the patient for spinal anaesthesia.

The patient was then placed in the lateral position with the side to be operated dependant and horizontal position of the spine was verified using a spirit level. With full aseptic precautions, after local infiltration with 1% lidocaine, spinal puncture was performed in the midline in the L3-L4 interspace using a 25 gauge spinal needle with the bevel directed to the dependent side of the patient. The-allocated drugs were administered slowly over 1 minute and the patient remained in the lateral decubitus position for 10 minutes from the start of injection of spinal drug. The time of intrathecal

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injection was considered time zero (T0). Oxygen was administered by face mask if required.

Heart rate and blood pressure was recorded using standard NIBP before intrathecal injection and thereafter at 2, 5 mins and then every 5 minutes during surgery and every 15 mins in the postoperative period until readiness for discharge criteria were met. A heart rate less than 50/min was to be treated with 0.5 mg intravenous atropine.

Sensory block height was assessed by loss of sensation to pin prick on the dependent side using a 22 gauge blunt hypodermic needle in the midclavicular line at 2, 5, and then every 5 minutes interval after injection until 2 consecutive levels of sensory block were identical. Surgery was initiated once the level of Sensory block reached Tl2. Block was considered as adequate when the sensory level reached Tl0. Assessments were continued every 15 minutes after completion of surgery until regression to S2 dermatome.

The degree of motor block was assessed by the modified Bromage scale.

0 - No motor blockade.

1 - Inability to raise extended leg but can flex knee.

2 - Inability to flex knee, can flex ankle.

3 - No movement, unable to flex ankle joint.

Assessment was done at 10 minutes after injection and then every 5 minutes until maximum block was achieved or until surgery was commenced. Assessment of motor block was then done at 15 minutes interval after completion of surgery and ceased once normal motor function returned. Successful unilateral spinal anaesthesia was defined as surgical anaesthesia (loss of pinprick sensation at T10, and motor score 2 or 3) on the dependent side only, while the non dependent side maintenance both somatic sensibility to pinprick test and motor score < 1 which was assessed at 10 and 30 mins after spinal injection.

The group allocations of the patients were delivered in an opaque sealed envelope just before surgery. All the patients received midazolam 7.5 mg orally 1 hour before being moved to the operating room (OR), where standard intraoperative monitoring, comprising electrocardiography, pulse oximetry and noninvasive blood pressure (NIBP), was instituted. A suitable peripheral vein was cannulated with an 18-G cannula and preloading was commenced with 500 ml of Ringer lactate solution. Baseline values of heart rate and blood pressure were noted and the patient was then placed in the lateral position with the side to be operated dependent and horizontal position of the spine was verified using a spirit level. All study solutions were prepared aseptically in identical syringes by an anaesthetist not involved with subsequent administration and patient assessment. The investigator was blinded as to the identity of the solution. All solutions were administered at room temperature. Under aseptic conditions, after local skin infiltration with 1% lidocaine, spinal puncture was performed in the midline in the L3-L4 interspace using a 25-G spinal needle with the bevel directed towards the dependent (operative) side of the patient. The study drug was administered slowly over approximately 1 minute and the patient remained in the lateral decubitus position for 10 minutes after completion of injection of spinal drug. This was considered time zero (T0). After turning the patient supine, a tourniquet was applied on the operative thigh and inflated to a pressure 100 mmHg above the patient's baseline systolic pressure. Oxygen was administered by face mask if required (SpO2 0.05) (Table 1). Readiness for surgery was achieved in all patients in all three groups and the spinal block success rate was 100%. No differences in the onset time of surgical block were observed among the three groups. There were no statistically

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significant differences in onset of sensory block to the T10 dermatome and time to achieve maximum sensory block between the three groups. The maximum height of sensory block achieved on the dependent side was T4 in Group R (in seven patients) and Group RC (in six patients) and T2 in Group RF (in two patients). The median height of sensory block was T5 in Group R and T6 in Group RF and RC. The duration of sensory block at T10 was similar in all groups. However, times for sensory regression of the block to S2 dermatome were significantly higher in Group RF (262.6 ± 44.67 min) compared with Group R (210.65 ± 39.39 min) ($p = 0.001$) and in Group RC (262.5 ± 37.7 min) as compared with Group R (210.65 ± 39.39 min) ($p < 0.01$)

Results

The 60 patients included in the study were comparable with respect to age, sex, ASA physical status, weight where height ($p > 0.05$) (Table 1). Readiness for surgery was achieved in all patients in all three groups and the spinal block success rate was 100%. No differences in the onset time of surgical block were observed among the three groups. There were no statistically significant differences in onset of sensory block to the T10 dermatome and time to achieve maximum sensory block between the three groups. The maximum height of sensory block achieved on the dependent side was T4 in Group R (in seven patients) and Group RC (in six patients) and T2 in Group RF (in two patients). The median height of sensory block was T5 in Group R and T6 in Group RF and RC. The duration of sensory block at T10 was similar in all groups. However, times for sensory regression of the block to S2 dermatome were significantly higher in Group RF (262.6 ± 44.67 min) compared with Group R (210.65 ± 39.39 min) ($p = 0.001$) and in Group RC (262.5 ± 37.7 min) as compared with Group R

TABLE 1: COMBINED PATIENT CHARACTERISTICS

Group (n=20)	**Age (yrs) Mean±SD**	**Sex**		**ASA Class**		**Weight (kg) Mean±SD**	**Height (cm) Mean±SD**	**BMI (kg/m^2) Mean±SD**
		M	**F**	**1**	**2**			
Gp R	32.3±13.3	18 (90%)	2 (10%)	20 (100%)	0	60.7±7.2	164.45±4.87	22.5±2.1
Gp RF	37.4±8.98	17 (85%)	3 (15%)	20 (100%)	0	61.65±7.74	164.05±5.88	22.84±2.24
Gp R+C	31.8±11.1	18 (90%)	2 (10%)	20 (100%)	0	62.7±9.92	164.5±6.31	24.7±3.84
P value	0.231	0.851		-		0.218	0.964	0.042

TABLE 2: SENSORY PARAMETERS

Sensory parameter	**Group R (n=20)**	**Group RF (n=20)**	**Group RC (n=20)**	**P value**			**P value combined**
				Group R vs RF	**Group R vs RC**	**Group RF vs RC**	
Onset to T10 (mins) Mean ± SD	2.7 ± 1.9	3.1 ± 2.26	2.3 ± 0.94	0.913	0.839	0.524	0.429

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Median height of sensory block attained	T_5	T_6	T_6	-	-	-	-
Time to maximum sensory block (mins) Mean ± SD	11.3 ± 5.17	11.7 ± 6.15	10.4 ± 5.86	0.995	0.941	0.874	0.765
Duration at T10 (mins) mean ± SD	131.9 ± 37	167.3 ± 40.7	157.8 ± 59.06	0.67	0.048	0.11	0.0537
Time for complete regression of sensory block (mins) Mean ± SD	210.65 ± 39.39	262.6 ± 44.67	262.5 ± 37.7	0.001	<0.01	1.00	0.000

Note: *p-value < 0.05. There was a statistically significant difference in the three groups in the time taken for regression of the sensory block (p = 0.000). Time taken for complete regression of sensory block was significantly longer in Group RF as compared to Group R (p = 0.001) and in Group RC as compared to Group R (p<0.01).

TABLE 3 MOTOR PARAMETERS

Table 3: Characteristics of motor blockade: values are presented as Mean ± SD or as median Note: *p-value

Motor parameter	**Group R (n=20)**	**Group RF (n=20)**	**Group RC (n=20)**	**P value**			**P value combined**
				Group R vs RF	**Group R vs RC**	**Group RF vs RC**	
Max. modified Bromage score	3	3	3	-	-	-	-
Time to reach maximum motor block	Within 10 mins	Within 10 mins	Within 10 mins	-	-	-	-
Time taken for complete motor regression (mins) Mean ± SD	123.9 ± 26.59	128.2 ± 24.9	156.0 ± 42.4	0.934	0.022	0.05	0.005
Grade 3 motor block achieved	19 (95%)	20 (100%)	20 (100%)	-	-	-	0.5

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TABLE 4 : TIME TO VOID

	Group R	**Group RF**	**Group RC**	**Group R vs RF**	**Group R vs RC**	**Group RF vs RC**	**P value**
Time to void (mins) Mean ± SD	333.15 ± 96.05	393.5 ± 128.28	419.5 ± 83.8	0.273	0.013	0.837	0.034

TABLE 5: TIME TO RESCUE ANALGESIA

	Group R	**Group RF**	**Group RC**	**Group R vs RF**	**Group R vs RC**	**Group RF vs RC**	**P value**
Time to requirement of 1st analgesic (mins) Mean ± SD	284.6 ± 95.35	382.5 ± 122.35	390.5 ± 82.5	0.023	0.002	0.993	0.002

Discussion

Rapid recovery from motor and sensory block is required to facilitate early mobilisation after day care surgeries such as knee arthroscopy. Many tried to achieve this The use of hyperbaric lidocaine 5% has declined due to concerns of cauda equina syndrome and transient neurological symptoms, which has aroused interest in alternative local anaesthetics and combinations to produce spinal anaesthesia of reliably short duration. Kallio and colleagues8 found that ropivacaine 15 mg provided a faster recovery of motor block, but a similar duration of sensory block to bupivacaine 10 mg. Wahedi et al.reported that loss of sensation at the T10 dermatome was achieved with 15 mg of ropivacaine, which prompted the use of this dose. The ED50 and ED95 for spinal ropivacaine in lower limb surgery of 50 minutes' duration or less have been found to be 7.6 and 11.4 mg, respectively. This provides a useful guide for clinicians to choose the optimal dose of spinal ropivacaine under different clinical situations.11 Fettes et al.12 provided fureliable spinal anaesthesia for a variety of surgical procedures of a relatively short duration. In the study 0.4 ml of 50% dextrose was added to 2 ml of 0.75% ropivacaine to make the solution hyperbaric and improve the success rate. The concentration of glucose used (66.6 mg/ml) was the easiest concentration to dispense using readily available solutions, and provided a solution that was sufficiently hyperbaric for its purpose. Cappelleri et al. found a strictly unilateral sensory block in 73% of patients receiving ropivacaine 7.5 mg 30 minutes after injection and unilateral motor block was observed in 94%. None of the patients in the study attained entirely unilateral anaesthesia probably because both the dose and volume were too high. The addition of both fentanyl 30 μg and clonidine 15 μg prolonged the duration of sensory block. This prolongation of sensory block by addition of adjuvants like fentanyl and clonidine has been proven by several earlier investigators.5,7,14–17 The antinociceptive properties of clonidine indicate that it might be useful as an alternative to intrathecal opioids for postoperative analgesia. However, while there was no significant prolongation of motor block in patients given intrathecal fentanyl, there was a significant prolongation of the motor block in patients who

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received intrathecal clonidine 15 µg along with ropivacaine. Van Tuijl et al.15 found that the addition rther evidence that a dose of 15 mg hyperbaric ropivacaine produces predictable andof 15 µg clonidine to 5 mg hyperbaric bupivacaine prolonged the duration of motor block by 25 minutes and seemed to improve the block quality in outpatient knee arthroscopy. The addition of 30 µg of clonidine instead of 15 µg did not further improve the quality of the block. M De Kock et al., 16 on the other hand, found that while 15 µg intrathecal clonidine was found to significantly improve the quality of the anaesthesia provided by 8 mg intrathecal ropivacaine in patients undergoing ambulatory knee arthroscopy, this was obtained without compromising the benefits of low-dose intrathecal ropivacaine, such as short-lasting motor block, early mobilisation and micturition. Urinary retention has been attributed to intrathecal opioids. However, voiding, in this study, was delayed more in the RC group compared with the RF group. Van Tuijl et al.15 reported a delay in spontaneous voiding with 15 µg of clonidine. This has been reported by other authors too and may be attributed to slightly lower intraoperative blood pressures due to the haemodynamic effects of clonidine resulting in less urine production. Clonidine, after neuraxial or systemic administration, affects arterial BP in a complex manner because of opposing actions at various sites. Whilst the α2-adrenergic agonists produce sympatholysis and reduce arterial BP through effects on specific brainstem nuclei and on sympathetic preganglionic neurons in the spinal cord, these effects are counteracted by direct vasoconstriction resulting from the α2-adrenergic agonists on the peripheral vasculature. As a result, the dose response for neuraxial clonidine on arterial blood pressure in humans is generally considered to be U-shaped. Combining α2-adrenergic agonists with local anaesthetics can potentially increase the degree of sympatholysis and the resulting hypotension.17–19 In the present study, there was a significantly lower heart rate recorded up to five hours after spinal administration of the study solution and a significantly lower diastolic blood pressure recorded at about six hours in those patients who received clonidine with ropivacaine. However, no episodes of hypotension or bradycardia were noted in any patient. Addition of both fentanyl 30 µg and clonidine 15 µg significantly prolonged the duration of sensory blockade when given with 15 mg ropivacaine made hyperbaric by the addition of glucose 6.66% and hence also prolonged the time to requirement of first rescue analgesic. The prolongation of the time for complete regression of the motor block by clonidine may be desirable when it is combined with a local anaesthetic with lesser motor blockade like ropivacaine for longer procedures but may be undesirable when early patient mobilisation is required. The prolongation of the time to micturition by clonidine 15 µg may also not be desirable for ambulatory surgery patients. The addition of fentanyl 30 µg may be superior to addition of clonidine 15 µg for ambulatory knee arthroscopy as it provides similar prolongation of sensory block without prolonging the duration of motor block and delaying time to voiding of urine. No patient in any group had excessive sedation, respiratory depression, shivering, nausea and vomiting or residual neurological deficit, post-dural puncture headache or transient neurological symptoms at follow-up. However, one of the drawbacks of the present study was that the baricity of the final spinal injectates amongst the three groups was not measured. This may have also influenced the results (knowing that the volume of injectate was equal amongst the groups).

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Conclusion:

1) Addition of fentanyl 30□g and clonidine 1□g significantly prolonged the duration of sensory blockade when given along with 15 mg ropivacaine made hyperbaric by the addition of. glucose 6.66% and hence also prolonged the time to requirement of first rescue analgesic.

2) Intrathecal clonidine 15 □g, but not fentanyl 30□g also significantly prolonged· the time for complete regression of the motor block. This may be desirable when it is combined with a local anaesthetic with lesser motor blockade like ropivacaine for longer procedures but may be undesirable when early patient mobilisation is required.

3) The time to micturation was also prolonged by the addition of clonidine 15 □g. This may, again, not be desirable for ambulatory surgery.

The addition of fentanyl 30 □g may be superior to addition of clonidine 15 □g for ambulatory knee arthroscopy as it provides similar prolongation of sensory block without prolonging the duration of motor block and delaying time to voiding of urine.

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