EFFECT OF INTRATHECAL DEXMEDETOMIDINE AS ADDITIVE FOR SUBARACHNOID BLOCK IN ARTHROSCOPIC ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION: A PROSPECTIVE RANDOMIZED DOUBLE BLIND STUDY

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ABSTRACT

Background and Aim: Dexmedetomidine, a highly selective α2 agonist has gained popularity as adjuvant in all modes of regional anaesthesia. We studied the characteristics of subarachnoid block with dexmedetomidine 5mcg added to hyperbaric bupivacaine in arthroscopic anterior cruciate ligament (ACL) reconstruction. **Methodology:** 50 ASA I & II patients were randomly allocated into two groups of 25 patients each. Group GS received 17.5mg 0.5% hyperbaric bupivacaine with 0.5ml normal saline, GDXM received 17.5mg hyperbaric bupivacaine with 5 mcg dexmedetomidine with normal saline in total 4ml volume. The onset and duration of sensory block, motor block, hemodynamics, postoperative analgesia and side effects were recorded. **Results**: The mean onset time for the sensory block to reach T8 dermatome and motor block to reach Bromage 3 grade was significantly less in GDXM than GS group. Time to regression of sensory block, motor block and time to rescue analgesia were significantly prolonged by addition of dexmedetomidine. GDXM required less number of rescue analgesic doses. **Conclusion**: Intrathecal use of dexmedetomidine 5mcg with 0.5% heavy bupivacaine provides a faster onset and prolonged duration of sensory as well as motor block along with prolonged postoperative analgesia.

KEYWORDS: Subarachnoid block, dexmedetomidine, adjuvant.

INTRODUCTION

Subarachnoid block is the most commonly used anaesthetic technique for lower limb and abdominal surgeries. Ever since its introduction, anaesthesiologists have used various adjuvants to prolong the duration of anesthesia and provide good pain relief in postoperative period.[1,2] Intrathecal opioids such as morphine and fentanyl have been the most commonly used adjuvants in subarachnoid block. However, opioids are associated with respiratory depression, pruritus, nausea, vomiting and urinary retention.[3] Dexmedetomidine is a highly selective alpha 2 agonist with analgesic, sedative and amnesic properties. It has wide range of uses in perioperative period and critical care settings. It is also emerging as a valuable adjunct in regional anaesthesia including peripheral nerve blocks.[4-6] Based upon the earlier human studies involving various dosages of dexmedetomidine we hypothesized that 5mcg of dexmedetomidine shall provide prolonged intraoperative anaesthesia and postoperative analgesia.[7]

MATERIALS AND METHODS

Hospital ethics committee approval was obtained. 50 ASA I and II adults scheduled for arthroscopic ACL reconstruction surgery under subarachnoid block were enrolled for this prospective, randomized double blind study. Patients with coronary artery disease, uncontrolled hypertension, allergy to study drug and infection at site of dural puncture were excluded. All patients were examined a day prior to the scheduled surgery and familiarized with numerical pain scale along with its relevance to postoperative pain relief protocol. Written informed consent was obtained from all of the patients. They were instructed to be nil orally after midnight and given alprazolam 0.25mg along with ranitidine 150mg per orally on the night prior as well as morning of surgery.

In our study we included MRI confirmed cases of ACL tear posted for arthroscopic reconstruction performed by the same surgeon to eliminate selection bias and surgical

technique bias to ensure comparability. Randomization was done with sealed enveloped technique and designated as Group GS and Group GDXM consisting 25 patients each for saline and dexmedetomidine respectively. Upon arrival to operation theatre in preoperative room an 18G intravenous access was established. Prilox 2% cream was applied at the site of dural puncture for local anaesthesia minimum 30min prior to procedure. Baseline haemodynamic parameters were recorded including heart rate, blood pressure, electrocardiogram and oxygen saturation.

Preloading was done with 5ml/kg of lactated ringer solution. We used lower volume of fluid for preloading because arthroscopic surgeries involve use of extensive irrigation leading to considerable systemic absorption which could result in higher incidence of urinary retention. Under all aseptic precautions subarachnoid block was performed at L3-4 intervertebral space level in lateral decubitus with operative site in dependent position using a 27G Whitacre needle. All patients received 17.5mg hyperbaric 0.5% bupivacaine. Additionally, study group GS received 0.5 ml preservative free 0.9% saline and group GDXM received dexmedetomidine 5mcg prepared in 0.5ml of solution intrathecally. Drugs for subarachnoid use were prepared by an anaesthesiologist who was not involved in study. Dexmedetomidine as well as normal saline were prepared in a separate 2ml syringe to avoid any effect on baricity of bupivacaine. Following intrathecal drug administration patients were kept in lateral decubitus for another 2min and then placed supine.

The onset of sensory block was defined as the time between injection of intrathecal anesthetic and the absence of pain at the T8 dermatome assessed by sterile pinprick every 2min till T8 dermatome was achieved.

Motor block was assessed with modified Bromage scale (0–3).

0: able to move the hip, knee and ankle.
1: unable to move the hip, but can move knee and ankle.
2: unable to move the hip and knee but can move the ankle.
3: cannot move the hip, knee and ankle.

Time for motor block onset was defined as modified Bromage score of 3. Complete motor block recovery was assumed when modified Bromage score was 0.

The period from spinal injection to the first occasion when the patient complained of pain in the postoperative period was considered as duration of spinal anesthesia. All durations were calculated considering the time of spinal injection as time zero.

A sensory block at T8 dermatomal level was considered to be adequate for surgery. Haemodynamic parameters were recorded 5min prior to procedure and continued during the intraoperative period. Any bradycardia defined as 20% below baseline value or heart rate less than 50bpm was treated with intravenous atropine 0.6mg and any decrease in mean arterial pressure below 20% of the basal reading or systolic BP less than 90 mm Hg was treated by fluid bolus and 3mg intravenous increments of mephentermine.

Postoperatively all the patients were assessed every 30min for sensory as well as motor block recovery. All patients received 1gm paracetamol intravenous 8hrly and pain scores were recorded by a trained orthopaedic nurse every hour. Any patient with numerical pain score 4 or more was supplemented with pethidine 50mg intramuscular. Total requirement of pethidine over 24 hr was also recorded. Incidence of nausea, vomiting and urinary retention were recorded.

RESULTS
The two groups were comparable with regards to age, sex, ASA status and duration of surgery.

Table 1 Demographic Data.

S No	Characteristics	Group GS	Group DXM	P Value	Test applied
1	Age (mean±SD)	33.48±6.02	30.76±5.56	0.13	Unpaired t- test
2	Sex (female/male)	3/25	2/25	0.99	Fisher's exact test
3	ASA status (II/I)	2/25	3/25	0.99	Fisher's exact test
4	Surgery Duration min (mean±SD)	49.05 ± 20.57	53.48 ± 21.03	0.49	Unpaired t- test

Sensory block onset time to reach T8 dermatome and motor block onset time to reach Bromage 3 was significantly less in group GDXM than group GS (P< 0.03 and P<0.05 respectively) as shown in table 2 and fig 1. The mean time for sensory block to reach T8 level was 5.71±1.90 min and 4.52 ± 1.60 min in group GS and GDXM respectively. Mean time for motor block onset was 10.43±3.09 min and 7.95±2.11 min in group GS and GDXM respectively. Block onset times were statistically significant as assessed by unpaired t test.

Figure 2 shows time taken for sensory regression to S1 and motor block regression to Bromage 0. The addition of dexmedetomidine resulted in prolongation of sensory regression to S1. The prolongation in time to regress in Group GS vs. group GDXM was highly significant statistically by unpaired t test. (p<0.001). Mean duration for regression of sensory block to S1 segment was 192±12.60 min in group GS and 273±18.36 min.

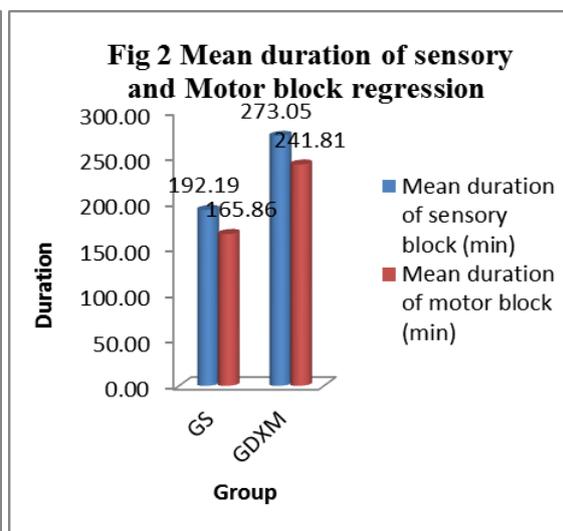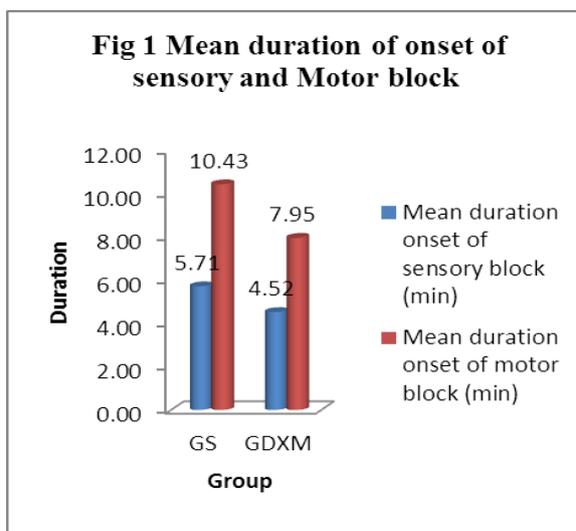**Table 2: Subarachnoid Block Parameters.**

S No	Characteristics	Group GS	Group DXM	P Value
1	Sensory Block onset (min ± SD)	5.71±1.90	4.52 ± 1.60	p< 0.03
2	Motor Block onset (min ± SD)	10.43±3.09	7.95±2.11	p< 0.05
3	Sensory Block regression time (min ± SD)	192±12.60	273±18.36	p<0.001
4	Motor Block regression time (min ± SD)	165.86±14.46	241.81±17.95	p<0.001
5	Time to rescue analgesia (min ± SD)	426.57±54.23	884±314	p<0.001

Similarly, regression of motor blockade to Bromage 0 was also prolonged by dexmedetomidine which was statistically significant. Mean durations were 165.86±14.46 min and 241.81±17.95 min in group GS and GDXM respectively.

Statistical analysis by unpaired t test showed that the time to first analgesic rescue was significantly prolonged in Group GDXM as compared to Group GS. Mean time to rescue analgesia was 426.57±54.23 min in GS group and 884±314 min in group GDXM as shown in table 2. Median duration of time to rescue analgesia is depicted in fig 3. Median Pain scores were assessed by Mann Whitney U test and found to be significantly low in group GDXM than group GS as shown in fig 4. Significant number of patients in group GDXM did not require a rescue analgesia even at 24 hrs and remaining required only one dose of intramuscular pethidine. All patients in GS group needed at least two rescue doses of pethidine at 6 and 12-16 hr postoperatively. All the patients were comfortable 24hrs after surgery and mobilized successfully with full weight bearing. No motor weakness or accidental falls were reported.

Fig 1 Mean duration of onset of sensory and Motor block

Fig 2 Mean duration of sensory and Motor block regression

All patients remained haemodynamically stable and parameters assessed at various time intervals showed no statistically significant differences. Episodes of hypotension and bradycardia were treated with inj. mephentermine 3mg bolus and inj. Atropine 0.6 mg respectively which were statistically insignificant. Incidence of nausea, vomiting and urinary retention were not significant on comparison.

Fig 3 Median duration of rescue analgesia (min)

Fig 4 Median VAS
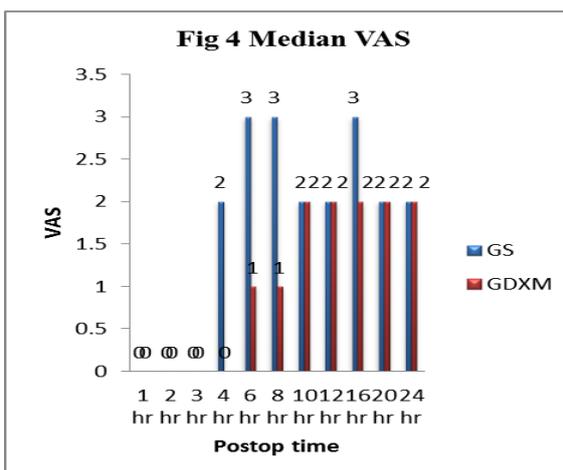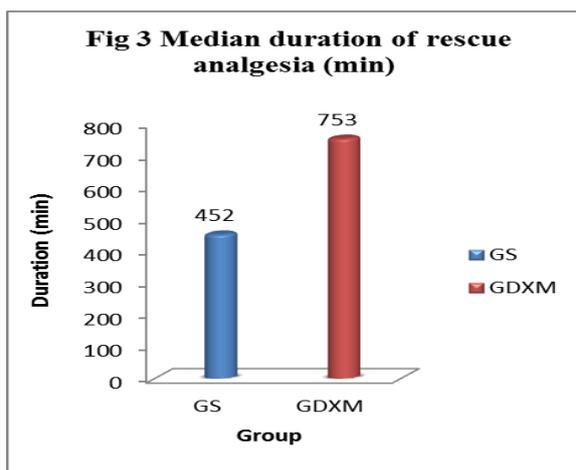
DISCUSSION

Duration of surgical anaesthesia and postoperative analgesia with subarachnoid block when solely performed with hyperbaric bupivacaine is limited which frequently lead to patient dissatisfaction. Systemic as well as intrathecal opioids such as morphine and fentanyl although provide reasonably good analgesia, are associated with severe nausea, vomiting, pruritus, respiratory depression. Use of systemic NSAID frequently causes allergic drug reaction, renal or hepatic toxicity.

Clonidine, the first α2 agonist to be introduced for clinical use met with little success. Dexmedetomidine is a highly selective α2 agonist with a selectivity ratio for α2 compared with α1 receptor of 1600:1 versus 220:1 for clonidine. It was introduced for human use as infusion for short term ICU sedation in 1999. Experience with clonidine encouraged various investigators to use dexmedetomidine and study its effect on characteristics of subarachnoid block and postoperative analgesia. α2 agonists have been found to be synergistic when used along with local anaesthetics for subarachnoid block. They cause pronged sensory as well as motor block with an extended postoperative pain relief since the two molecules act at different sites and by different mechanism. Sodium channels are blocked by local anaesthetics whereas the α2 adrenergic agonists act by binding to presynaptic C-fibers and postsynaptic dorsal horn neurons. Intrathecal local anesthetics when supplemented with dexmedetomidine prolongs the sensory block by depressing the release of C-fibers transmitters and by hyperpolarization of postsynaptic dorsal horn neurons. α2 agonists bind to motor neuron in the dorsal horn of the spinal cord which can explain prolonged motor blockade. α2 agonists have anti-nociceptive action for both somatic and visceral pain, therefore, use of dexmedetomidine as an additive to hyperbaric bupivacaine causes significant prolongation in duration of analgesia[6-10]

Al Mustafa MM et all studied role of 5mcg and 10mcg dexmedetomidine along with 2.5ml of 0.5% isobaric bupivacaine adjusted to a total volume of 3ml in subarachnoid block for patients undergoing urological surgeries. They recorded dose dependent dependent faster onset and prolonged duration of sensory as well as motor blockade with stable haemodynamics. However they did not monitor its impact on postoperative analgesia.[11] We used the dose of only 5mcg, our findings are consistent with them.

Rajni Gupta et all compared dexmedetomidine 5mcg and fentanyl 25mcg with 12.5mg bupivacaine heavy in 3ml drug volume for lower abdominal surgeries and concluded that dexmedetomidine had prolonged sensory and motor blockade with no difference in onset, additionally it provided pain relief upto 6hrs.[12] We used Dexmedetomidine alone as an additive and found similar prolongation of sensory and motor blockade but we also find early onset of sensory and motor blockade when Dexmedetomidine was combined with Bupivacaine.

Vidhi Mahendru et all compared intrathecal dexmedetomidine 5mcg, clonidine 30mcg and fentanyl 25mcg in lower limb surgeries as additive to 0.5% hyperbaric bupivacaine in 3ml volume. They found that intrathecal dexmedetomidine is associated with prolonged sensory and motor block, stable hemodynamics and reduced demand of rescue analgesics in 24 h as compared to clonidine and fentanyl. However, there was no significant difference in onset of blockade amongst the groups.[13] We found similar prolongation of duration, there was a definite shortening of the onset time as well.

Shagufta Naaz et all compared various doses of subarachnoid dexmedetomidine ranging from 5 to 20mcg diluted to 0.5ml volume along with 2.5ml 0.5% hyperbaric bupivacaine in Indian population and found dose dependent faster onset along with delayed regression of sensory as well as motor block. They reported similar effect on postoperative analgesia however they found approximately 30% incidence of haemodynamic instability with more than 10mcg dose. They reported higher sedation scores and even respiratory depression with higher doses.[14] Since we stuck to 5mcg dose we didn't encounter much of haemodynamic instability.

All the mentioned studies have confirmed the prolonged duration of sensory and motor block. Reports are conflicting about the effect on onset of blockade although most of these studies have used a similar volume of drug for subarachnoid block but the studies using multiple doses of dexmedetomidine have not only reported a faster onset of blockade but also this effect was found to be dose dependent. In our study we used 3.5ml of hyperbaric bupivacaine with dexmedetomidine which a relatively high dose and must have caused an additive effect on the faster onset of sensory and motor blockade.

CONCLUSION

In our study we selected a specific population scheduled for a similar sugery conducted by single surgeon in a tertiary care orthopaedic center to eliminate biases to maximum possible extent. Based upon the above findings we conclude that 5mcg intrathecal dexmedetomidine when used as an adjuvant to hyperbaric bupivacaine in subarachnoid block causes prolonged sensory and motor block with excellent postoperative pain relief extending upto 24 hrs in arthroscopic anterior cruciate ligament reconstruction.

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