

**Original research article****Effectiveness Of Dexmedetomidine In Bilateral Total Knee Arthroplasty: A Prospective Study****<sup>1</sup>Karagathara Vimalkumar, <sup>2</sup>Pastagiya Anand D., <sup>3</sup>Joshi Harshadrai, <sup>4</sup>Jethwa Shaileshkumar**<sup>1</sup>Senior Resident, Department of Anesthesiology, Kiran Medical College, Surat, Gujarat, India<sup>2</sup>Sr. Registrar, Department of Anesthesiology, Kiran Medical College, Surat, Gujarat, India<sup>3</sup>Assistant Professor, Department of Orthopaedics, Kiran Medical College, Surat, Gujarat, India<sup>4</sup>Assistant Professor, Department of Internal Medicine, Kiran Medical Collage, Surat, Gujarat, India**Corresponding Author:**

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**Abstract**

**Introduction:** Although the use of dexmedetomidine to spinal anaesthesia is becoming more and more common, there isn't much agreement on the recommended dosage. Higher dosages of dexmedetomidine are not advised due to dose-related lengthening of motor blockade duration and an increase in the incidence of side effects, such as bradycardia and hypo tension.

**Aim:** To assess the effectiveness of intrathecal dose of dexmedetomidine (10µg) in conjunction with 0.5% hyperbaric bupivacaine in terms of the anaesthesia & quality, specifically enhance the duration of spinal anaesthesia, hemodynamic stability, adequate surgical field, the side effects of dexmedetomidine, and the time required to initiate rescue analgesia.

**Material and Method:** 29 patients were randomly selected by American Society of Anaesthesiologist (ASA) Grade I and II orthopaedic patients who were posted bilateral TKR and were between the ages of 45 and 70. Ten microgram (µg) of injectable dexmedetomidine (0.5 ml, reconstituted using normal saline) were given to with the total study drug volume remaining constant at 3.5 millilitres for each of the 29 patients. Time to first postoperative rescue analgesia, intraoperative hemodynamic stability and complications.

**Result:** Out of 29 participants, 4 (13.79%) were males and 25 (86.21%) were females. Mean age was 62.41 years. 7 (24.14%) persons had ASA 1, 22 (75.86%) had ASA 2. Mean Pre-OP Systolic BP was 145.31 mm Hg with SD 14.27. Mean Systolic BP after 15 min was 123.03 mm Hg with SD 11.54. There decrease in Systolic BP from pre-OP to after 15 min was very highly statistically significant. Systolic Blood Pressure very significantly decreases from Pre-OP to after 15 minutes, 30 mins, 45 minutes, 60 minutes, 2 hrs, 6 hrs, 12 hrs, 18 hrs and 24 hrs. Mean Pre-OP Diastolic BP was 88 mm Hg with SD 6.37. Mean Diastolic BP after 15 min was 73.03 mm Hg with SD 6.77. There decrease in Systolic BP from pre-OP to after 15 min was very highly statistically significant. Diastolic Blood Pressure very significantly decreases from Pre-OP to after 15 minutes, 30 mins, 45 minutes, 60 minutes, 2 hrs, 6 hrs, 12 hrs, 18 hrs and 24 hrs. Mean Pre-OP Heart rate 78.41/minute with SD 12.94. Mean heart rate after 15 min was 69.79/minute with SD 11.75. There decrease in heart rate from pre-OP to after 15 min was very highly statistically significant. Heart rate very significantly decreases from Pre-OP to after 15 minutes, 30 mins, 45 minutes, 60 minutes, 2 hrs, 6 hrs, 12 hrs, 18 hrs and 24 hrs.

**Conclusion:** The maximum positive impact of dexmedetomidine can be attained without any side effects when used as an additive in spinal anaesthesia at a dose of 10 µg (in 0.5 ml volume).

**Keywords:** Lumbar puncture, motor blockade, postoperative rescue analgesia, surgical field

**Introduction**

When performing bilateral total knee replacement surgeries, spinal anaesthesia is most frequently employed. When used in isolation for spinal anaesthesia, hyperbaric bupivacaine 0.5% has a comparatively short half-life, necessitating rescue with epidural anaesthesia if the surgical procedure goes longer than the medication's half-life<sup>[1]</sup>. Throughout the years, a variety of medications have been added to spinal anaesthesia to speed up its onset, shorten the period before surgery, extend its duration, and offer sufficient postoperative analgesia. These medications include many opioids and non-opioids, midazolam, ketamine, fentanyl, and clonidine. Constipation, nausea, vomiting, pruritis, and respiratory depression are among the adverse effects of opioid use that can be quite upsetting for the patient<sup>[5]</sup>.

Dexmedetomidine, a highly selective  $\alpha_2$  agonist, has quickly become the preferred additive for spinal anaesthesia due to its ability to provide stable hemodynamics, analgesia and awake sedation without respiratory depression<sup>[4]</sup>. Dexmedetomidine has been used in several studies<sup>[1,2,5]</sup> by different authors at doses of 3 µg, 5 µg, 10 µg, and 15 µg. The duration of motor blockade may be prolonged in relation to

dose, and the incidence of side effects, such as bradycardia and hypotension, may increase<sup>[5]</sup>. As a result, it appears that opinions regarding the appropriate dosage of dexmedetomidine to add to hyperbaric bupivacaine in spinal anaesthesia for routine use are divided. A pain-free perioperative period and the avoidance of dexmedetomidine side effects are essential for the successful completion of any surgical procedure.

The purpose of this study is to examine the effects of intrathecal administration of dexmedetomidine (10 ug) in combination with 0.5% hyperbaric bupivacaine on hemodynamic stability, acceptable surgical field, incidence of side effects (hypotension and bradycardia), and postoperative analgesia in orthopaedic patients undergoing bilateral total knee replacement surgeries.

## Materials and Methods

The study was a prospective randomized clinical trial conducted at KIRAN MULTISPECIALITY HOSPITAL, SURAT, GUJRAT, India. After the approval of the Ethical Committee of the Institute, 29 ASA Grade I and II orthopaedic patients between the ages of 50 to 75 years who were undergoing TOTAL BILATERAL KNEE ARTHROPLASTY surgeries were included in the study. All patients were screened in the pre anaesthesia clinic prior to taking up for surgery. Written consent was taken from all the patients enrolled in the study. Uncooperative patients, patients with uncontrolled hypertension and diabetes, patients with allergy to the study drugs, patients with height less than 150 cm and patients having condition which are contraindication to spinal anaesthesia such as patient refusal, infection at site of injection, coagulopathy, increased intracranial pressure were excluded from the study.

## Inclusion Criteria

1. Age 50-75 Years
2. ASA Grading 1 And 2
3. Willing Patient

## Exclusion Criteria

1. Uncooperative patient.
2. Uncontrolled hypertension and diabetes.
3. Allergy to drugs.
4. Height < 150cm.
5. Contraindication of spinal anaesthesia.

All patients received 15 mg of 0.5% hyperbaric bupivacaine along with 10 µg of Inj. Dexmedetomidine (0.5 ml, reconstituted with normal saline). The total volume of study drug was kept constant in all 29 patients (3.5 ml).

Prior to performing lumbar puncture, standard monitoring including electrocardiography, pulse oximetry and non-invasive blood pressure measurement was done and patient was co-loaded with 15 ml/kg body weight of ringer lactate. Lumbar puncture was done using 25 gauge Quinke spinal needle via median approach in L3-L4 intervertebral space with patients in sitting position under full aseptic precaution. Successful placement of spinal needle in sub arachnoids space was confirmed by aspiration of cerebrospinal fluid and the study drug was injected over 10 second period and the patients were placed supine after the drug was injected.

Haemodynamic monitoring was done every 15 minutes for the first hour then on every hour up to 2 hours then on every 6 hourly for next 24 hour using an automated multichannel monitor.

Fall in systolic blood pressure to less than 90 mm Hg or less than 30% of baseline value was defined as hypotension and was treated with Inj. Mephenteramine 6 mg bolus doses in increments. Similarly, bradycardia was defined as fall in heart rate to less than 60 beats per minutes and treated with Inj. Atropine 0.3 mg bolus doses. After the end of surgery, patient was shifted to the Post Anaesthesia Care Unit (PACU) and was discharged from PACU once the modified Aldret score was nine or more<sup>[7]</sup>.

All the data's were analysed using IBM SPSS statistical software version 23.0. Mean ± SD between the groups with a p-value of less than 0.05 was considered significant. Chi-square test was used for qualitative data analysis.

## Results

Effect of Dexmedetomidine on Bilateral Total Knee Replacement surgeries.

Main components of observations are

1. Increase duration of surgery
2. Intra operative vitals stability
3. Good surgical field to operate
4. Good analgesia up to 24 hours
5. Least complication as compared to other additives

In our study out of 29 participants, 4 (13.79%) were males and 25 (86.21%) were females. The Mean age of participants was 62.41 years (table-1). As per ASA grading was 7 (24.14%) participants had ASA 1, 22 (75.86%) participant had ASA 2. Mean duration of surgery was 7.30 hrs with SD± 2.31.

Mean Pre-OP Systolic BP was 145.31 mm Hg with SD±14.27. Mean Systolic BP after 15 min was 123.03 mm Hg with SD 11.54. One tailed Paired t-test showed that calculated t value was 19.19, p value 5.95E- 18 (~<0.00001) with degree of freedom 28. There decrease in Systolic BP from pre-OP to after 15 min was very highly statistically significant. Systolic Blood Pressure very significantly decreases from Pre-OP to after 15 minutes, 30 mins, 45 minutes, 60 minutes, 2 hrs, 6 hrs, 12 hrs, 18 hrs and 24 hrs (Table-2). Mean Pre-OP Diastolic BP was 88 mm Hg with SD 6.37. Mean Diastolic BP after 15 min was 73.03 mm Hg with SD 6.77. One tailed Paired t-test showed that calculated t value was 14.08, p value 1.56E- 14 (~<0.00001) with degree of freedom 28. There decrease in Systolic BP from pre-OP to after 15 min was very highly statistically significant. Diastolic Blood Pressure very significantly decreases from Pre-OP to after 15 minutes, 30 mins, 45 minutes, 60 minutes, 2 hrs, 6 hrs, 12 hrs, 18 hrs and 24 hrs (Table-3). Mean Pre-OP Heart rate 78.41/minute with SD 12.94. Mean heart rate after 15 min was 69.79/minute with SD 11.75. One tailed Paired t-test showed that calculated t value was 15.83, p value 8.43E-16 (~<0.00001) with degree of freedom 28. There decrease in heart rate from pre-OP to after 15 min was very highly statistically significant. Heart rate very significantly decreases from Pre-OP to after 15 minutes, 30 mins, 45 minutes, 60 minutes, 2 hrs, 6 hrs, 12 hrs, 18 hrs and 24 hrs (Table-4).

**Table 1:** Demographic parameter

Criteria	Mean ± SD
Age	62.41 ± 8.4
Sex (Male: Female)	04:25:00
Duration	7.3±2.3
Asa grade (One: Two)	07:22:00

**Table 2:** Systolic blood pressure

	Mean	SD
Pre operative	145.3103448	14.26560161
15 min	123.0344828	11.54643655
30 min	106.5517241	12.46591412
45 min	106.5862069	10.10486885
60 min	106.2758621	8.939864779
2 hours	107.6206897	8.178428914
6 hours	117.3793103	9.32130353
12 hours	124.3448276	9.711097709
18hours	129.2413793	8.339472287
24 hours	131.5862069	7.277741218

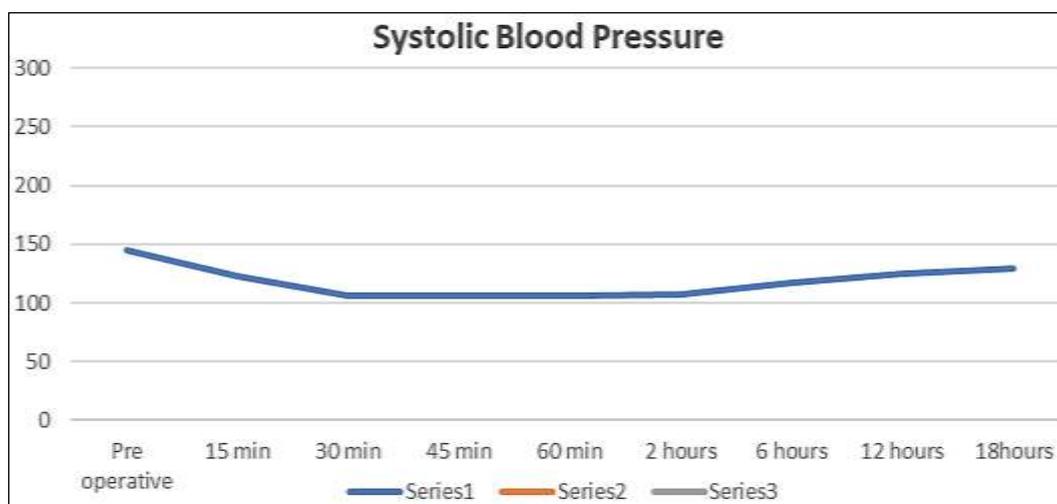


Table 3: Diastolic blood pressure

	Mean	SD
Pre operative	88	6.369570517
15 min	73.03448276	6.774335806
30 min	63.93103448	9.643395351
45 min	63.37931034	8.436374446
60 min	63.5862069	7.808041831
2 hours	63.72413793	5.599085077
6 hours	69.44827586	4.436747577
12 hours	74.62068966	6.212969115
18hours	76.96551724	6.383476206
24 hours	79.5862069	4.939037221

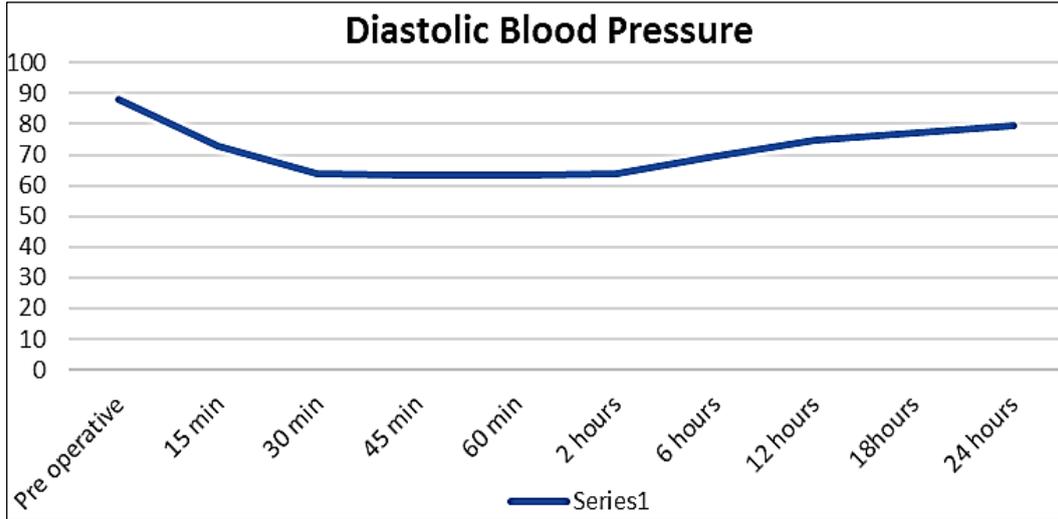
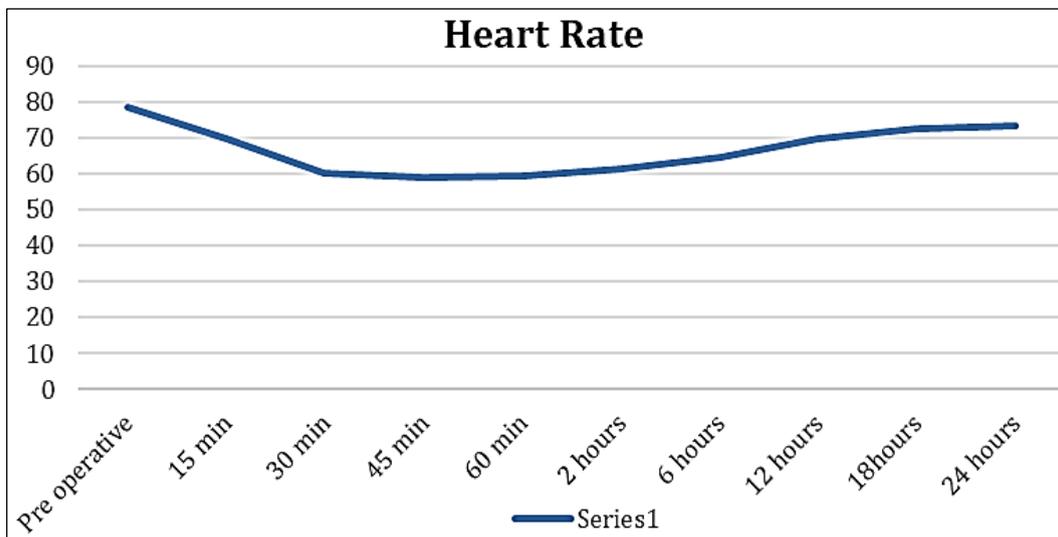


Table 4: Heart rate

	Mean	SD
Pre operative	78.4137931	12.94360637
15 min	69.79310345	11.75153276
30 min	60.20689655	8.077213586
45 min	58.96551724	6.98203183
60 min	59.34482759	5.030449157
2 hours	61.44827586	4.65668649
6 hours	64.62068966	5.129841219
12 hours	69.65517241	6.548041485
18hours	72.4137931	7.158996545
24 hours	73.31034483	6.508804193



## Rescue drug required for analgesia:

Out of 29 patient only six patient required rescue drugs, remaining 23 patient being comfortable up to 24 hours. Due to low visual analogue score (VAS) early mobilization possible with dexmedetomidine.

## Complication

Different type of complication can also be measured during this study. Most common complications are bradycardia, hypo tension, arrhythmia etc. In our study out of 29 sample only two patient had develop complications. One patient develop bradycardia and another one had develop hypo tension.

## Surgical field

In our study adequacy of surgical field access by the operating surgeon, whether adequate or requirement of the tournicute or not. In our study we found that out of 29 patient only four required tournicute rest of the procedure surgeon are comfortable with adequate surgical filed.

## Discussion

In our study, we found that dexmedetomidine in a dose of 10µg in 0.5 ml volume is an effective additive to hyperbaric bupivacaine 0.5% in spinal anaesthesia producing good haemodynamic stability during the intraoperative period, good surgical field, less requirement of tourniquet, prolong duration of anesthesia and a prolonged postoperative analgesia. The dose dependent side effects of dexmedetomidine namely hypotension and bradycardia were seen with doses of 10µg.

Researchers have been investigating the possibility of using dexmedetomidine as an additive in spinal analgesia since the FDA approved it for use in humans as a short-term medication for sedation/analgesia in the intensive care unit. This is because dexmedetomidine has a highly selective agonistic action for intrathecal  $\alpha_2$  receptors, which have antinociceptive effects on both somatic and visceral pain [8]. Dexmedetomidine prolongs the sensory block by hyperpolarizing post-synaptic dorsal horn neurons and suppressing the release of C fibre transmitters<sup>[9, 10]</sup>.

Patients were randomly assigned into three groups of thirty patients each in the study by Shaikh SI and Dattatri R. The first group received 15 mg of 0.5% hyperbaric bupivacaine with normal saline, the second group received 15 mg of hyperbaric bupivacaine with 5 µg, and the third group received 15 mg of hyperbaric bupivacaine with 10 µg of dexmedetomidine with normal saline, for a total volume of 3.5 ml<sup>[11]</sup>.

Zhang Y *et al.* conducted a meta-analysis on the impact of varying intrathecal dexmedetomidine doses on spinal anaesthesia. The analysis included nine studies with a Jaded score of 3-5 on different intrathecal dexmedetomidine doses, and the results showed that while increasing the dose of intrathecal dexmedetomidine may prolong the action of spinal anaesthesia, it also increases the risk of bradycardia<sup>[12]</sup>. The duration of postoperative analgesia was comparable to that attained by higher doses of dexmedetomidine as in other studies, but the incidence of hypotension and bradycardia was not significant when using 3 µg and 5 µg doses intrathecally.

According to a study by Nayagam HA *et al.*, 5 µg of dexmedetomidine is the recommended dosage for using it as an additive in spinal anaesthesia<sup>[2]</sup>. The results of our investigation show that a 5 µg dose of dexmedetomidine produces a longer duration of postoperative analgesia than a 3 µg dose. In a study by Sudheesh K *et al.*, patients undergoing ambulatory perianal surgeries were given dexmedetomidine in doses of 3 µg and 5 µg in addition to spinal anaesthesia. The researchers observed that during the intraoperative period, both groups' haemodynamic parameters changed similarly, with an overall gradual decrease below the baseline value<sup>[6]</sup>. In our study, we have documented a comparable pattern of changes in hemodynamics.

All patients enrolled in the study were followed up in the orthopaedics outpatient department for six months after the study concluded and were found to have no neurological sequelae that could be attributed to intrathecal dexmedetomidine administration.

## Limitation

Due to the limited sample size and the inclusion of all bilateral total knee arthroplasty cases in the study, there was variation in the length of operation. Bilateral total knee arthroplasty cases may have been included in the study to assure homogeneity in the length of surgery and time to initial rescue analgesia, so reducing the study's limitations. In summary spinal anaesthesia can be effectively supplemented with dexmedetomidine to achieve stable hemodynamics and sustained postoperative analgesia. When dexmedetomidine is used at a dose of 10µg (in a 0.5 ml volume), its maximum positive effects can be achieved.

**Financial or Other Competing Interests:** None.

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