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A Comparative Evaluation of Intra-Articular Bupivacaine vs Bupivacaine and Dexmedetomidine for Postoperative Analgesia in Arthroscopic Knee Surgeries: A Study Protocol

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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Study Protocol

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ABSTRACT

Background: Various degrees of pain is seen in the post-operative period following almost every arthroscopic knee surgery. The reason behind this pain is due to the irritation that occurs to the nerve endings that are found free in the synovium of the knee. Hence, to make this difficult period pain free various analgesics are given to the patient. They are given through various routes and they may be given as sole analgesics or in combination. One such routes used is the intra-articular route in which analgesics are given intra-articularly for post -operative analgesia. Dexmedetomidine is a drug which can be used the aforementioned route. The main of this study is to evaluate the effectiveness of Intra-articular Dexmedetomidine as an adjuvant to Intra-articular Bupivacaine.
Aim: This study aims to compare Intra-articular Bupivacaine vs Bupivacaine and Dexmedetomidine for prolonging post-operative analgesia following knee arthroscopy surgery.
Objectives: The primary objective is to assess the duration of postoperative analgesia produced by Dexmedetomidine when used as an adjuvant to Intra-articular Bupivacaine after arthroscopic knee surgeries. The secondary objectives are to evaluate Dexmedetomidine as an adjuvant to Intra-articular Bupivacaine, with respect to:

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1. Quality of analgesia,
2. Number of doses of rescue analgesic required during study period,
3. Systemic/Local side effects.

Methods: 60 patients within the age group 20-60 undergoing arthroscopic knee surgeries will be enrolled for the study. Following the completion of surgery, patients allotted to Group B will receive 19ml of Intra-articular Bupivacaine with 1ml of normal saline and patients allotted to Group D will receive 19 ml of Intra-articular Bupivacaine with 1mcg/kg Dexmedetomidine. Post-operative analgesia will be monitored using VAS and the requirement of rescue analgesics in both groups will be noted down and compared.

Expected Outcomes: The VAS and total requirement of rescue analgesics is expected to be less in Group D with minimal/no side effects.

Keywords: Intra-articular dexmedetomidine; intra-articular bupivacaine; arthroscopic knee surgeries; post-operative analgesia; VAS; meniscal tears; meniscectomy; ACL repair; ACL; paracetamol.

1. INTRODUCTION

The role of the modern anesthetist has evolved from providing the patient with intra-operative care to providing all round care. The period immediately following surgery and pain management is also an integral part of the treatment plan of the patient. Hence efficiently managing pain in the post-operative period is as crucial as pain management in the intra-operative period. An anesthetist must take into account that post-operative pain is not just due to tissue injury, but it is a culmination of various neurophysiological interactions. Thus, post-Operative [1] analgesia becomes much difficult and the ideal pain management is still elusive. One of the major goals of the anaesthetist should be to relieve surgical pain with minimal side effects. The Joint Commission for Accreditation of Health Organization insists on the usage of a numerical pain scale periodically and also use it as a criteria for discharge. Analgesics provides comfort as well as decreases the response of the sympathetic nervous system, and Thus avoids tachycardia and hypertension [2].

2. SYSTEMIC RESPONSES TO POST-OPERATIVE PAIN

There is a transmission of nociceptive stimuli that moves to the CNS from the peripheries.

This thus creates the neuroendocrine stress response. There is an interaction occurring between the hypothalamus, pituitary, adreno cortical and sympathoadrenal systems. And hence this post-operative pain can affect all organs of the body.

2.1 Cardiovascular Effects

There is an increase in the blood pressure, heart rate, irritation of the myocardium and systemic vascular resistance as a response to pain. Aggravation of ischemia in the myocardium may also be seen as a result of increase in oxygen demand to the myocardium.

2.2 Respiratory Effects

There is an increase seen in the total oxygen consumption by the body and also in the amount of carbon dioxide produced as a result of pain. Minute ventilation is also found to be increased. Pulmonary functions are also found to be compromised in thoracic/abdominal surgeries because of pain. There is a restriction in movement of the chest wall which in turn results in decrease of tidal volume and functional residual capacity of the lung. Intra pulmonary shunting, hypoventilation, atelectasis and hypoxemia are also seen. Pain causes impairment of cough that results in patients finding it difficult to clear secretions.

2.3 Gastrointestinal and Urinary Effects

Retention of urine and ileus due to enhancement of sympathetic tone may occur. There is also evidences of increased secretion of gastric acid that causes stress ulcers. The combination of these two factors increases the chances of the patient having pneumonitis due to aspiration.

2.4 Neuro-Endocrine Effects

There is an increase in sodium water retention. A rise in blood glucose levels, lactic acid, free fatty

acids and ketones are seen as catabolic hormone quantity increases and the anabolic hormone quantity decreases. Negative nitrogen balance also leads to delay in the recovery period and less than satisfactory wound healing.

2.5 Hematological Effects

Due to increase in stress the adhesion of platelets increase and fibrinolysis decreases. These in turn cause a hypercoagulability state that leads to deep vein thrombosis and myocardial infarction.

Knee arthroscopic surgeries are done very commonly across the globe in recent times. In these procedures there is excessive surgical resection of the anterior fat pad, synovium and joint capsule. This resection in turn causes excessive post operative pain to the patient.

Providing adequate post-surgery pain relief is of utmost importance to promote early rehabilitation and discharge. Hence, intra-articular analgesics can be used to decrease the [3] intensity of pain.

Post-operative analgesia must be effective, safe and feasibility. Opioids and NSAIDs are administered post surgery in an attempt to provide relief from pain. However there are multiple other strategies that are being used to provide analgesia. They are however not completely devoid of limitations.

Dexmedetomidine when given systemically produces sedation, analgesic and anaesthetics sparing effects and also acts as a sympatholytic. Evidences also suggest that the use of exmedetomidine intra-articularly either as a solo drug or in a combination with other drugs decreases the pain associated with arthroscopic surgeries. Dexmedetomidine targets nociceptive receptors that are located in the periphery and hence the usage of dexmedetomidine as an adjuvant to Bupivacaine administered to the patient when the surgery ends would be an alternative and provide adequate analgesia. The study is planned to evaluate the efficacy of Dexmedetomidine as an adjuvant to Intra-articular Bupivacaine after knee arthroscopy to provide a longer duration of analgesia following surgery.

2.6 Aim

This study aims to compare Intra-articular Bupivacaine vs Bupivacaine and Dexmedetomidine for prolonging post operative analgesia following knee arthroscopy surgery.

2.7 Objectives

- The primary objective is to assess the duration of postoperative analgesia produced by Dexmedetomidine when used as an adjuvant to Intra-articular Bupivacaine after arthroscopic knee surgeries.
- The secondary objectives are to evaluate Dexmedetomidine as an adjuvant to Intra-articular Bupivacaine, with respect to:

1. Quality of analgesia,
2. Number of doses of rescue analgesic required during study period,
3. Systemic/Local side effects.

2.8 Research Question

Whether Dexmedetomidine administered as an adjuvant to Intra-articular Bupivacaine at the end of arthroscopic knee surgeries is effective in prolonging the duration of postoperative analgesia without significant side effects.

2.9 Hypothesis

Generated Hypothesis: Intra-articular Dexmedetomidine administered as an adjuvant with Intra-articular Bupivacaine at the end of arthroscopic knee surgeries may be effective in prolonging the duration of postoperative analgesia without significant side effects.

Null Hypothesis: Intra-articular Dexmedetomidine administered as an adjuvant with Intra-articular Bupivacaine at the end of arthroscopic knee surgeries may not be effective in prolonging the duration of postoperative analgesia without significant side effects.

3. MATERIALS AND METHODS

3.1 Study Period

2 year

3.2 Study Area

Department of Anaesthesiology JNMC & AVBRH, Wardha.

3.3 Research Design

Prospective Randomized Control Study.

3.4 Study Population

Patients aged between 20-60 years.

3.4.1 Inclusion criteria

- ¬ Patients who give consent to act as a participant,
- ¬ Patients undergoing arthroscopic knee surgeries,
- ¬ Patients aged – 20-60 years,
- ¬ Patient with ASA class I and II.

3.4.2 Exclusion criteria

- ¬ Patients with a history of
- Elevated renal parameters,
- Elevated hepatic parameters,
- Heart diseases of ischemic nature,
- Disease related to heart valves,
- Systemic Hypertension,
- Consumption of narcotics or non steroidal anti inflammatory drugs a day prior to surgery.
- History of cancer, sepsis,
- Clotting disturbances and disorders,
- Drug allergy.
- ¬ Patients who don't consent to participate in the study.

3.5 Sample Size and Technique

Sample-size calculation is based on the total consumption of rescue analgesia (mg) in both groups. Based on the results of previous study each group should have at least 21 patients.

The error α was kept at 0.05 and the power of the study was established to be 80%. The sample size is calculated using openepi.com. As the possibility of patients dropping out in the middle of the study the sample size is kept at 30 patients in each group.

Hence the study is planned to be conducted on a total sample size of 60. There will be two groups and each group will be divided into 30 patients each after getting approval from the Institutional Ethics Committee, DMIMS, Wardha.

3.6 Plan for Preoperative Assessment

- ¬ History will be taken in detail from the patient and the patient will undergo a general examination.

The findings of the same will be noted down in the proforma.

- ¬ Prior to initiation of the procedure the patient will be explained about the procedure in detail.

This will be done so as to increase the trust and to gain their confidence. Risks and benefits associated with the procedure will also be explained. If the patient is willing to go ahead with the study consent will be taken.

- ¬ 6 hours before the commencement of the surgery patients will be kept nil per oral.
- ¬ The vitals of the patient will be evaluated in pre operative room. Heart rate, SpO2 and blood pressure values will be noted down.
- ¬ The selected patients will be randomly allocated into two groups.
  - GROUP B - Patients will receive 19ml of intra-articular Bupivacaine 0.5% + 1ml of normal saline following surgery.
  - GROUP D – Patients will receive 19ml of intra-articular Bupivacaine 0.5% + Dexmedetomidine (1µg/kg) at the end of surgery.

Before the administration of anesthesia the methods will be explained to the patient again.

Monitors will be attached and heart rate, SpO2 and blood pressure will be taken down. After giving the anesthesia patient will be monitored on the above-mentioned parameters. Dural puncture will be performed with the patient in the sitting position. It will be given at L3-L4 interspace. Midline approach will be followed and a 25G Quinckes needle will be used for the same. 3 ml of 0.5% Hyperbaric Bupivacaine will be injected through the needle into the intrathecal space and the patient will be positioned supine for the surgery.

3.7 Study Procedure

After the completion of the surgery, drugs will be handed over to the operating surgeons in un-named syringes. GROUP B Patients will receive 19ml of intra-articular Bupivacaine 0.5% + 1ml of normal saline and GROUP D Patients will receive 19ml of intra-articular Bupivacaine 0.5% + Dexmedetomidine (1µg/kg).

The severity of postoperative pain at 0, 1, 2, 4, 6, 12 and 24h will be evaluated. VAS scale will be

used for pain evaluation and will range on a scale from 0 to 10.

If the VAS score is greater than 4, Inj. Paracetamol 1g will be injected intravenously and will be repeated every 8h or whenever required. Rescue analgesic will be administered based on the VAS score and the time of administration will be charted. Complications associated with the administration of Dexmedetomidine such as hypotension, bradycardia, vomiting, sedation and nausea will be noted.

VAS SCORE - Patients feedbacks regarding pain shall be recorded on the scale of 0 to 10, with minimal pain on zero and maximal pain on ten.

3.8 Plans for Statistical Analysis

Relevant clinical data will be analyzed using appropriate statistical test to find the significant association in clinical factors between the two groups using tables & graphs. Assumption of normality will be ascertained by the use of Kolmogorov–Smirnov test. To compare the two groups data will be represented as mean ± SD and also a sample t-test will be used.

Number/frequencies will be used to describe data in categorical format. The same will be compared using chi-square test or Fisher's exact test. If the p-value is found to be < 0.05 then the data will be considered to be of statistical significance.

4. OBSERVATIONS AND RESULTS

After the completion of the study, data will be collected and recorded in a systemic manner, statistical analysis will be done according to protocol and results will be submitted.

5. DISCUSSION AND CONCLUSION

Shaimaa F Mostafa et al. compared IA Bupivacaine vs IA Bupivacaine & Dexmedetomidine after arthroscopic knee surgeries to determine the quality of analgesia and also to check the duration. They concluded that using Dexmedetomidine in addition to intra-articular Bupivacaine increases the analgesic duration, decreases the consumption of painkillers to alleviate pain. They also noted a significant decrease in the visual analogue scores and a great [4] increase in the patients satisfaction. All these were present with little to no side effects.

El-Hamamsy et al. did a study to compare fentanyl and dexmedetomidine as an adjuvant to IA Bupivacaine. They found that both the drugs provided a efficacy similar to each other but better than sole administration of bupivacaine. They concluded that when dexmedetomidine was added at 1 µg/kg to bupivacaine there was a significant improvement in the quality of analgesia following arthroscopic knee surgeries. They also found that the time taken for the request of rescue analgesic was 450 ± 85 min as compared to bupivacaine with which the first request was at 230 ± 85 min. There was also decreased requirement of meperidine on the [5] post-operative Paul et al. did a study where dexmedetomidine was added as an additive to ropivacaine. They concluded that addition of the same resulted in a better quality analgesia and also increased the duration of first rescue analgesic request. In the study it was noted that there was decrease use of fentanyl with an average of 10.84 ± 2.6 h between intra articular injection of study [6] drugs and analgesics supplementation provided by means of PCA pump.

Other related [7-12] studies on bupivacaine and dexmedetomidine were reviewed Akca et al. concluded that no adverse effects was seen on the cartilage of rat knees when dexmedetomidine was used. However, they did not comment on its action on humans.

CONSENT

Written and informed consent will be obtained from all the patients prior to enrolment in this study.

ETHICAL APPROVAL

The proposed study will take place getting approval of the Ethics and Screening Committee of JNMC, DMIMS (DU) & AVBRH, DMIMS, Sawangi (M), Wardha.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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