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Pain Relief Following Arthroscopy: Comparative Study Between Intraarticular Bupivacaine, Neostigmine and Fentanyl

Ruchi Tandon[1], Anshu Priyanka Lakra[2], Neelesh Nema[3]

[1]Professor [2]Senior Resident [3]Assistant Professor, Department of anaesthesiology, Gandhi Medical College, Bhopal, Madhya Pradesh 462001, India.

Abstract

In spite of arthroscopic surgeries being minimally invasive, they cause significant post-op pain. Intra-articular administration of local anaesthetics with or without adjuvants or opioids alone are known to produce post-op analgesia of varying degrees and duration. The purpose of this study was to compare the effects of intra-articular bupivacaine, neostigmine and fentanyl after arthroscopic surgeries. 45 patients were randomized to receive intra-articular bupivacaine, neostigmine and fentanyl after arthroscopic surgery under spinal anaesthesia. Visual analog pain scores (VAS), duration of analgesia as defined as time for first demand for parenteral analgesics and the total subsequent consumption of analgesics was evaluated. There was significant difference of duration of analgesia between the three groups being estimated from Time Zero to the time when the VAS score was greater than 6 and medication for pain was administered. Duration of analgesia was more prolonged in Group III (Fentanyl) as compared to Group I (Bupivacaine) and Group II (Neostigmine). Also, duration of analgesia in Group I was significantly prolonged as compared to Group II. These changes were statistically highly significant when compared to each other ($p<0.05$). Among all the groups, no significant side-effects were observed.

Keywords: Arthroscopy; Intra-articular Bupivacaine; Neostigmine; Fentanyl.

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Introduction

Surgical trauma with tissue damage and surgical pain is a universal phenomenon which is aggravated by associated muscle spasm and visceral distention. Once the luxury of anaesthesia is over, the patient has to face the misery of post-operative pain. Relief of operative as well as post-operative pain is important because it interferes with respiration, bowel movements and micturition [1,2].

The problem of post-operative pain relief has been receiving most attention since past few years [3,4,5].

Various methods of post-operative pain relief have been tried like analgesia by narcotics and non-narcotics, regional technique viz.,

Corresponding Author: Anshu Priyanka Lakra, Senior Resident, Department of Anesthesiology, Gandhi Medical College, Bhopal, Madhya Pradesh 462001, India.

E-mail: anshu.priyanka14@gmail.com

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continuous extradural analgesia, various nerve blocks, extradural and intrathecal narcotics, inhalational agents, transcutaneous nerve stimulation, cryoanalgesia of individual nerve, acupuncture, hypnosis and relaxation techniques [5]. Narcotics like fentanyl, sufentanil and remifentanil have been introduced but still have to establish their place in routine practice [5,6].

Nerve blocks using local anaesthetics have limited use in selective operations and have drawbacks like multiple infections, repeated blocks, toxic reactions, fair degree of competence and experience and known failure rates [5,7].

Arthroscopy, a minimally invasive alternative to standard open surgical techniques results in less postoperative swelling than open techniques, lesser pain, decreased risk of complications, and improved recovery times and a quicker return to full function [8].

Post-operative analgesia has significant role in increasing joint mobility, improving muscle strength and providing ealy mobilization after surgery [9].

Intra-articular administration of drug has been used to provide better analgesia after arthroscopic knee surgery and to reduce consumption and possible side effects of oral and intravenous anesthetics [9,10].

Inra-articular injection of various local anaesthetics with or without adjuvants following arthroscopy have found to be active upon cessation of surgery, have a prolonged duration of action, are easy to administer and without serious side effect.

Material and Methods

After approval for the study from Institutional Ethics Committee, written informed consent was obtained from all patients after explaining the nature of the clinical study and the drugs to be used. Patients were drawn from those scheduled for Arthroscopy knee surgery requiring subarachnoid block for surgery.

The day before surgery, the study groups were introduced to a 100 mm VAS with 0 as an indication of no pain at all and 100 as an indicator of the worst possible pain.

Inclusion Criteria

45 Patients of both sexes

1. 18 to 40 years in age
2. ASA 1 and ASA 2

Scheduled for arthroscopic surgeries under spinal anesthesia were included in this study. Patients were randomized into three groups using envelope method, containing 15 patients of each group according to the various drug injected for study.

Exclusion Criteria

1. Any previous history of allergic reaction to bupivacaine, neostigmine or fentanyl.
2. Patient with contraindication to regional anesthesia.
3. Patient receiving analgesics within 24 hrs prior to surgery
4. ASA III and IV patients
5. Weight > 100 kg

All eligible patients were randomized using envelope method and assigned to one of the three groups:

Group I: Intra-articular injection of 20 ml 0.5% Bupivacaine (P).

Group II: Intra-articular injection of 20 ml normal saline + 500 mcg Neostigmine

Group III: Intra-articular injection of 20 ml normal saline + 100 mcg Fentanyl

Anesthesia Technique

In the operating room, each patient had multi parameter monitor attached. Baseline pulse rate, non-invasive blood pressure, oxygen saturation and respiratory rate were obtained and recorded before induction of spinal anesthesia. A venous access was secured using 16 or 18 gauge cannula and the patient was preloaded with Ringer lactate (10 ml/kg) before the induction of spinal anesthesia.

Spinal anaesthesia was scheduled for all patients using Bupivacaine (H) 0.5% in appropriate volume without any adjuvants. Lumber puncture was performed under aseptic precautions in sitting or lateral position using 25 G lumber puncture needle. All analgesics were avoided in pre and intra-operative period.

All patients were given inflation of a thigh tourniquet of 300-350 mm Hg before beginning of surgery.

At the conclusion of surgery, the appropriate study drug was administered through intra-articular injection in a randomized manner from a coded syringe into the joint space via 18 G Needle. (TIME ZERO). Time Zero was noted (ie placement

of drug in intra-articular space).

Pulse rate, non-invasive blood pressure, oxygen saturation, respiratory rate, VAS score and the level of residual spinal blockade were recorded after intra articular injection of a drug before shifting. The tourniquet was then deflated and the patient shifted to the post-operative room.

Post-Operative Monitoring

In the post-operative room, an observer, blinded to the group assigned to the patient, noted the pulse, blood pressure, SpO_2 and VAS scoring at hourly intervals for 4 hours from Time Zero and subsequently at 2 hourly intervals for next 24 hours.

The time when the patient first requested pain medication was recorded.

Statistical Analysis

The data obtained was subjected to statistical analysis with the consultation of a statistician. Statistical analysis was done using computer software (SPSS version 20).

The qualitative data were expressed in proportion and percentages and the Quantitative data expressed as mean and standard deviations. The difference in proportion was analyzed by using Chi square test and the difference in means were analyzed by using one way ANOVA. Significance level for tests was determined as 95% ($p< 0.05$).

Observations And Results

1. Demographic data

After randomization, it was observed that out of 45 patients, 24 (53.3%) were male as compared to 21 (46.7%) female patients. It was also observed that 21 (46.6%) patients belong to ASA Grade I and 24 (53.3%) patients belong to ASA Grade II.

In the present study mean age in Group I was (31.40 ± 8.89) years, (30.07 ± 12.51) years in Group II and (26.67 ± 6.35) years in Group III. The mean weight of patients in this study was (60.00 ± 6.85) kg in Group I, (62.53 ± 6.78) kg in Group II and (58.18 ± 6.71) kg in Group III. All three groups were similar in terms of age and weight as their difference is statistically insignificant (Fig. 1).

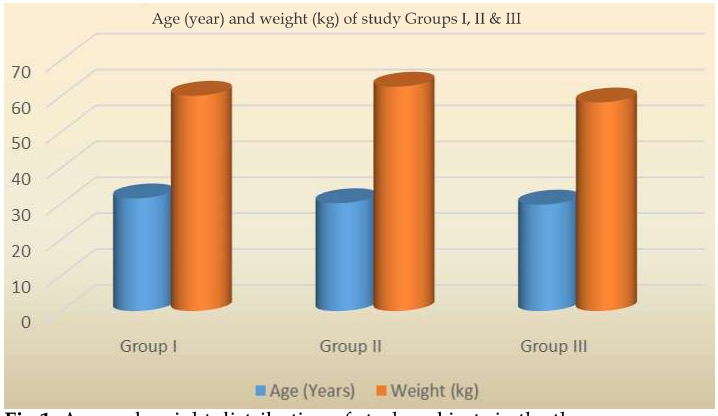

Fig 1: Age and weight distribution of study subjects in the three groups.

2. Haemodynamic parameters

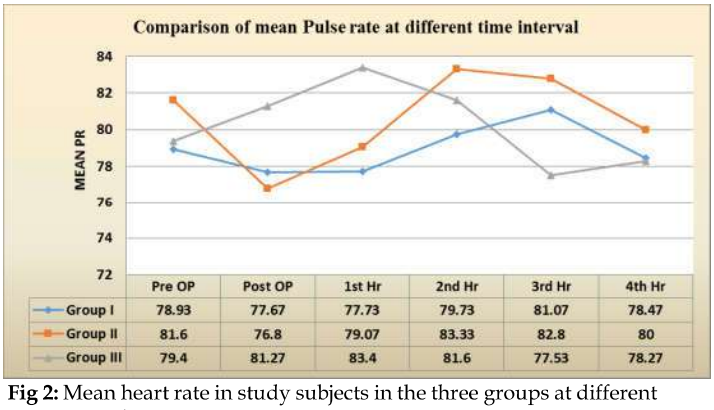

Fig 2: Mean heart rate in study subjects in the three groups at different time intervals.

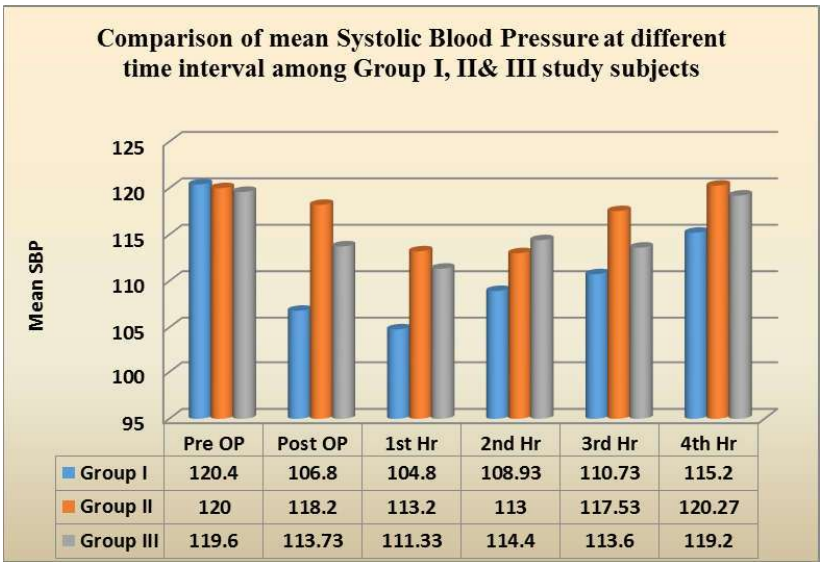

Fig 3: Mean systolic blood pressure in study subjects in the three groups at different time intervals.

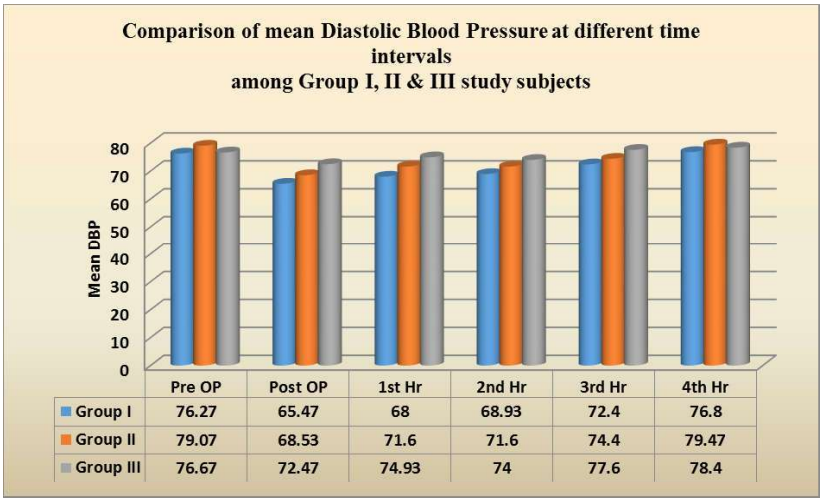

Fig 4: Mean diastolic blood pressure in study subjects in the three groups at different time intervals.

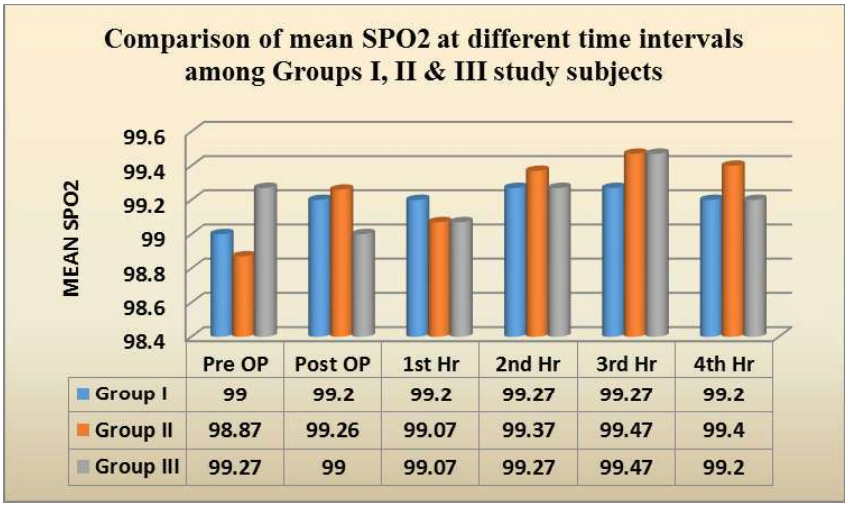

Fig 5: Mean SpO_2 in study subjects in the three groups at different time intervals.

The difference in mean pulse rate, mean systolic blood pressure, mean diastolic pressure and mean SpO_2 in the study in each group is not statistically significant (p>0.05). So we concluded that intra-articular bupivacaine, neostigmine and fentanyl have similar effects on the haemodynamics of the patient (Fig. 5).

3. Duration of analgesia

There was significant difference in duration of analgesia between the three groups. Analgesia lasted (5.60 ± 1.24) hours for Group I, (4.87 ± 1.64) hours for Group II and (10.73 ± 3.36) hours for Group III. The difference in mean was found to be highly significant in favour of Group III and was estimated from time zero to the time when the VAS score was greater than 5 and medication for pain was administered. Duration of analgesia was more prolonged in Group III as compared to Group I and Group II. Whereas duration of analgesia in Group I was significantly prolonged as compared to Group II. These changes were statistically highly significant when compared to each other (p<0.05) (Fig. 6).

Table 1: Mean duration of analgesia in study subjects in the three groups at different time intervals.

Groups	Duration of Analgesia (Hrs)		ANOVA 'F' Value	P Value
	Mean	SD		
Group I	5.60	1.242	29.492	0.001 (highly significant)
Group II	4.87	1.642		
Group III	10.73	3.369		
Total	7.07	3.454		

4. Need for supplementary analgesia

Figure reveals the need of supplementary analgesia among Groups I, II and III. 9 (60.0%) patients in Group I, 13 (86.7%) patients in Group II and 4 (26.7%) patients in Group III needed supplementary analgesia (iv Tramadol 50 mg). The need for supplementary analgesia was significantly higher in Group II and lowest in Group III as compared to Group I. The difference was found to be highly significant (p= 0.004).

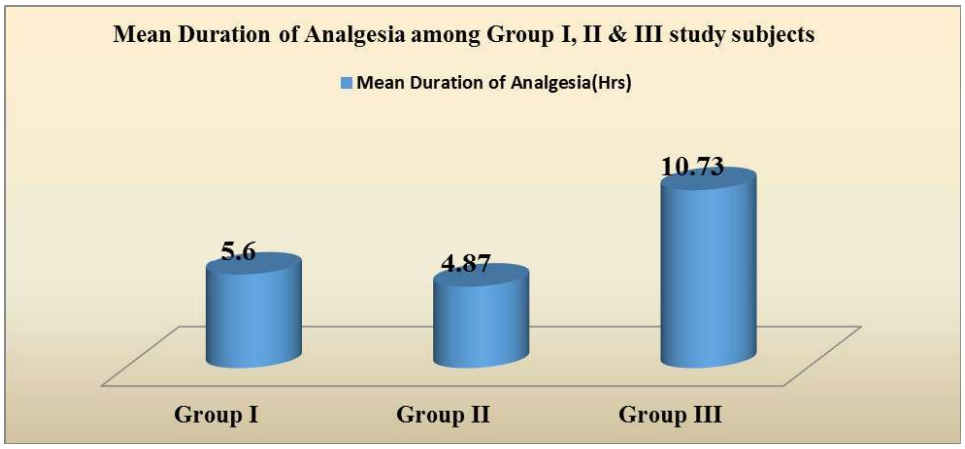

Fig. 6: Mean duration of analgesia in study subjects in the three groups at different time intervals.

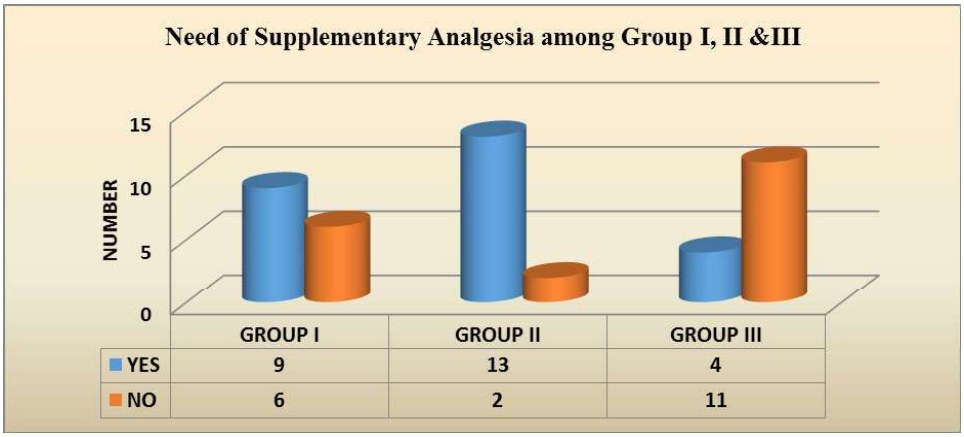

Fig. 7: Need of supplementary analgesia among Groups I, II and III

5. Incidence of adverse effects

Figure 8 shows the adverse effects encountered in three groups. Hypotension was reported in 4 patients (26.7%) in Group I, 2 patients (13.3%) in Group II and none in Group III. Nausea, vomiting and bradycardia was reported 1 patient (6.7%) in each group. However, itching was reported in 3 patients (20%) in Group III. 30 patients (66.7%) did not record any side effects. Side effects such as hypotention, nausea, vomiting, bradycadia may occur due to residual effect of sub arachnoid block. These side effects were statistically non-significant (p=0.251) when compared to each other.

6. Visual Analog Scale Score

Figure 9 shows comparison of mean VAS Score at different time interval till 24 hours from Time Zero among Group I, II & III study subjects. There was no significant difference in the VAS score between all the groups at one hour post-operatively due residual central neuraxial block. Initially the mean VAS score was gradually increasing in all the three groups. From Time Zero to 24 hours post-operatively, the mean VAS score in Group II was highest as compared to Group I and III. Mean VAS score in Group III was significantly lower as compared to Group I and II. When compared to each other, these scores were statistically. highly significant (p<0.05) at 2 hour, 3 hour, 4 hour, 6 hour and 8 hour, significant in 10 hr and 12 hr and not significant in 14 hr, 16 hr, 18 hr, 22 hr & 24 hr. Thus we concluded that quality of analgesia is best in Group III as compared to Group I and II.

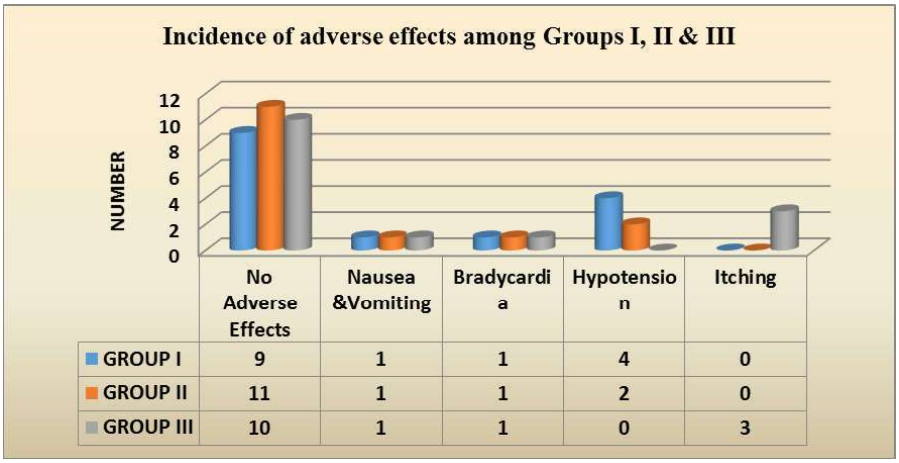

Fig. 8: Adverse effects encountered in study subjects in Groups I, II & III

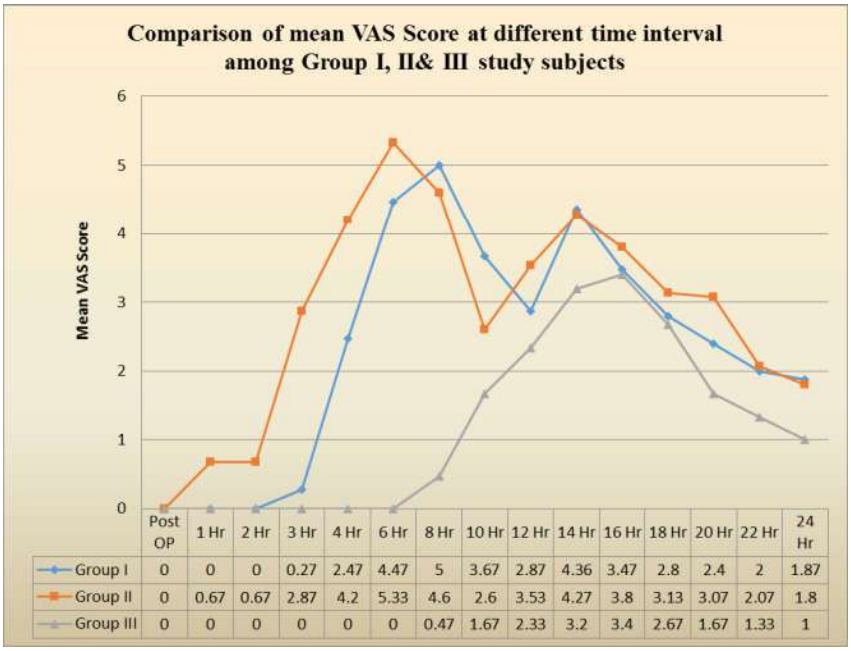

Fig. 9: Mean VAS Score at different time interval in study subjects in Groups I, II & III

Discussion

Arthroscopic knee surgery is one of the most common orthopedic procedures performed in the outpatient setting. Although knee arthroscopy causes less trauma than open surgery, considerable postoperative pain can hinder a patient's ability to participate in early rehabilitation. Systemically-administered analgesic agents, neuraxial blockades, local anesthetic infiltration, and intra-articular injections are the leading methods in use for post-op analgesia [2].

Local anesthetics are commonly used for intra-articular analgesia. Bupivacaine is the most commonly used local anesthetic for this purpose. [3,4,6]. Intra-articular injection of bupivacaine with or without adjuvants following arthroscopy has been demonstrated to be safe and effective in providing post-operative analgesia, found to be active upon cessation of surgery, having a prolonged duration of action, easy to administer and without serious side effect [5,8]. Opioids were also considered as analgesics following intra-articular surgery after opioids receptor were demonstrated not only in brain and spinal cord, but also in peripheral tissues. Recently new interest has focused on the cholinergic system that modulates pain perception and transmission. The acetylcholine esterase inhibitor neostigmine has demonstrated a dose dependent analgesia following spinal [16,17] or epidural anesthesia [3] and provides additive analgesia when administered simultaneously with alpha-adrenergic agonists and opioids [8,16,17]. Vomiting, nausea, headache, bradycardia, hypotension and pruritus limit the subarachnoid administration of neostigmine.

Raj et al. [6] found that intra-articular injection of morphine was more effective than intramuscular injection of the same dose of morphine in postoperative pain control. In their study, Alagol et al. [7] administered tramadol through intra-articular and intravenous routes in the same doses. The authors concluded that duration of analgesia was longer and incidence of adverse effects was lower when drugs were given by intra-articular route.

Keeping these studies in view, we conducted the present study by intra-articular administration of three drugs to provide better analgesia after arthroscopic knee surgery and to reduce need of consumption and possible side effects of oral and intravenous anesthetics [2,7].

Yang LC, Chen LM, Wang CJ 1998 [8] compared intra-articular (500 microg) neostigmine and intra-articular morphine. Analgesia lasted longer after 500 microg intra-articular neostigmine (350 ± 126 min) compared with intra-articular morphine (196 ± 138 min; $p < 0.05$). No significant analgesic effects were observed for the two lower doses of intra-articular neostigmine. Among all study groups, no adverse effects were observed.

Lt Col. Rashmi Datta, Brig TP Madhusudan, MJAFI 2004;60;123-127 [9] found that intraarticular injection of neostigmine 500 ugm decreases the requirement of supplementary opioid analgesia significantly. Addition of bupivacaine does not prolong the duration of neostigmine analgesia [12] significantly while intra-articular bupivacaine alone has a short but marginally more dense analgesic effect.

Qi-bin, Shi-Donliu et al., 2015 [10] studied the effect of single administration of intra-articular bupivacaine in arthroscopic knee surgery. They concluded that VAS score at 2,4,6,12 and 24 hr post operatively were significantly lower, the no. of patients requiring supplementary analgesia was smaller and the time first request for analgesia was longer in the intra-articular bupivacaine group than in placebo group.

Vita Varkel, Gershon Volpin et al. 1999, [11] compared the analgesia produced by comparable dose of intra-articular morphine and fentanyl. They concluded that VAS score for intraarticular fentanyl and intraarticular morphine were similar at one hr but thereafter were less for intraarticular fentanyl group.

P. Mandal, A.H Saudagar 2002 [13] found that intraarticular administration of fentanyl 50 mcg provided prolonged postoperative analgesia with mean VAS score of 0 at 8 hr and 1.25 ± 1.02 subsequently at 24 hr which was statistically highly significant. This was similar to the results of the study performed by Jawish et al. [14] which determined that the addition of 50 µg of fentanyl to bupivacaine prolonged the analgesic effect to 9 hours which was also corroborated by Pooni JS, Hickmott K et al. [15] when they compared intra-articular fentanyl and intra-articular bupivacaine for postoperative pain relief after knee arthroscopy.

In the present study, we found

- Duration of post-op analgesia is prolonged with intra-articular bupivacaine, neostigmine and fentanyl but it is more for fentanyl.
- Requirement of supplementary analgesia is highest in neostigmine and lowest in fentanyl
- Intra-articular Bupivacaine, neostigmine and fentanyl have no significant effects on the haemodynamics of the patient.

- Incidence and frequency of side effects for bupivacaine, neostigmine and fentanyl is not significant. While hypotension, bradycardia, nausea and vomiting can occur due to residual effect of sub arachnoid block.

Conclusion

Thus, from our study we conclude that bupivacaine, neostigmine and fentanyl can be used intra-articularly for post-operative pain relief following arthroscopy effectively. All provide post operative analgesia but prolongation is more with fentanyl than with bupivacaine and neostigmine.

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