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Original Research Article

An Observational Study of Adductor Canal Block using Ropivacaine Alone and with Additives (Dexmedetomidine/Fentanyl) for Post Operative Analgesia in Patients Undergoing Knee Arthroscopic Surgeries

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Conflict of interest: Nil

Abstract:

Objectives: The present study was to assess the post-operative analgesia in adductor canal block in knee arthroscopy patients.

Methods: Patients of either sex in the age group of 18-75 years, having body mass index (BMI) of 20-35 kg/m2 and belonging to ASA (I & II), who were scheduled to undergo elective knee arthroscopic surgeries were observed in this study. Group A patients were received 20ml of 0.2% Ropivacaine + 2ml of Normal Saline (total 22ml). Group B patients were received 20ml of 0.2% Ropivacaine + 0.25mcg/kg of Dexmedetomidine diluted in 2ml of Normal Saline (total 22ml). And group C patients were receiving 20ml of 0.2% Ropivacaine + Fentanyl 1mcg/kg diluted in 2ml of Normal Saline (total 22ml).

Results: Average duration of surgery in group A was 72.3+16.62 minutes, group B was 71.2+14.67 minutes and group C was 73.9+14.07 minutes. Visual analogue scale was found highest in group A and lowest in group C. Median VAS score of group C was statistically lower than median VAS score of group B and median VAS score of group B was statistically lower than group A. VAS was monitored postoperatively at 0 hours, 2 hours, 4 hours, 6 hours, 8 hours, 10 hours, 12 hours, 16 hours, 20 hours. Total consumption of analgesia (IV Tramadol) in 24 hours in Group A was 200±28.76mg, Group B was 142±41.53mg and Group C was 108.9±30.64mg. The difference in total analgesic consumed among the three groups during 24 hours was statistically significant. Total quantity of analgesia required was significantly less in Group C, followed by Group B and was maximum in Group A among the three study groups(P value<0.001).

Conclusions: The addition of fentanyl and dexmedetomidine to ropivacaine for adductor canal block increases postoperative analgesia time and reduces total amount of analgesic consumed postoperatively.

Keywords: Adductor canal block, Ropivacaine, Dexmedetomidine/fentanyl.

Introduction

Pain is not just a sensory modality but an experience. The International Association for the Study of Pain defines pain as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage [1]. Different categories of pain can be defined according to the duration, etiology, or perception of the painful experience [2]. These include acute pain, chronic pain, neuropathic pain, nociceptive pain and inflammatory pain. One of the common complaints in postoperative period is acute postoperative pain. Knee arthroscopy is a common orthopedic procedure worldwide [3]. Despite its minimally invasive nature compared to the traditional knee surgery, post-arthroscopic pain may be severe, and the patients generally require a significant amount of opioid-based analgesics after such procedures. Several patients experience narcoticrelated complications, such as sedation, respiratory depression, nausea, vomiting and constipation following excessive use of opioid analgesics. Peripheral nerve blocks offer effective analgesia and decrease the need for opioids, thereby reducing the complications associated with the use of this class of drugs [4,5]. Other benefits of peripheral nerve blocks include reduction in hospital resource utilization,[12] improved postoperative recovery,[6,7] and improvement in patient satisfaction [8]. Moreover, postoperative pain relief is an important factor in the early ambulation and rehabilitation of patients after knee surgery[9,10].

Postoperative pain is an important consequence of knee surgeries that can affect early ambulation, range of motion and duration of stay in hospital. Advanced surgical techniques like arthroscopies and

early mobilization after surgery have made knee surgeries more patients friendly.

Although arthroscopic procedures are minimally invasive surgeries, patients can experience severe pain during the early postoperative period [11]. Optimal pain relief is essential for functional recovery after knee arthroscopy. Appropriate pain management after arthroscopic knee surgery allows for faster recovery, reduces the risk of postoperative complications, and improves patient satisfaction. Contemporary pain management regimens following arthroscopic knee surgery include oral analgesics, periarticular injection, local anaesthetic infiltrations, peripheral nerve blocks (PNBs), and intravenous patient controlled analgesia (PCA) [12,13]. Multimodal analgesia is achieved by combining different analgesics that act by different mechanisms and at different sites in the nervous system, resulting in additive or synergistic analgesia with lowered adverse effects of sole administration of individual analgesics [14].

As peripheral nerve block (PNB) provide effective and synergistic pain relief when used as part of a multimodal regimen, they are considered to be an essential part of the current multimodal pain management protocol following arthroscopic knee surgery [15]. Given excellent pain relief and the opioid sparing effect, femoral nerve block (FNB) is commonly used as an analgesic modality and is considered the standard PNB in patients undergoing arthroscopic knee surgery [16]. However, FNB is followed by a significant decrease in quadriceps muscle strength, resulting in delayed mobilization, which is associated with the potential risk of falling [17,18, 19]. Adductor canal block (ACB) on the other hand is a predominantly sensory block and can be used as an alternative for postoperative analgesia after knee arthroscopy.

One of the earliest work leading to the development of the adductor canal block was done by Vander Wal et al [20] (1993) in Canada. They established the block's clinical viability using cadevers. They described what they referred to as “subsartorial approach” to the saphenous nerve blockade. Their intent was to describe an alternative to a traditional landmark approach to the saphenous nerve block, primarily for foot and ankle procedures. This established a foundation for clinicians to incorporate a regional blockade of the saphenous nerve to provide analgesia for surgical knee procedures.

Adductor Canal Block

As a purely sensory nerve the saphenous nerve innervates the medial side of the lower leg and foot; albeit with significant inter-patient variability. The adductor canal block involves injection of local anaesthetic into the adductor canal deep to the sartorius muscle and is a technically easy and reliable method for blocking the saphenous nerve. This may be useful for post-operative analgesia after knee, foot or ankle surgery (usually in combination with a popliteal block). It will also result in block of the infra-patellar nerve, which may be useful for postoperative analgesia after knee arthroscopy or anterior cruciate ligament (ACL) repair. Adductor canal block (ACB) is a highly successful approach to the saphenous nerve (also known as saphenous nerve block), that was first described by Vander Wal et al. [21] Compared with FNB, ACB results in less reduction in the quadriceps muscle strength as only the motor nerve to the vastus medialis of the quadriceps muscle traverses the adductor canal [4]. The adductor canal block (ACB) is newer compartment block of the saphenous nerve performed at the level of lower third of the thigh so that much of the motor innervation of the quadriceps group is spared, thus preserving much of the quadriceps strength making early ambulation and rehabilitation safer. The most significant advantage of the ACB over femoral nerve block and other techniques is that it is predominantly a sensory block and reduces the incidence of fall after knee surgeries.

Aims and Objectives

To assess the post-operative analgesia in adductor canal block in knee arthroscopy.

Material and Methods

This study was an Observational study and was conducted from November 2018 to October 2020 in the Bone and Joint Hospital, an associated hospital of Government Medical College, Srinagar, during routine working hours for various elective knee arthroscopic surgical procedures.

Selection of Cases

After obtaining proper approval of the Institutional Ethical Committee and informed consent was obtained from all the patients who were to be observed during the study. Patients of either sex in the age group of 18-75 years, having body mass index (BMI) of 20-35 kg/m2 and belonging to ASA (I & II), who were scheduled to undergo elective knee arthroscopic surgeries were observed in this study.

A detailed history, thorough physical examination and relevant laboratory investigation were conducted in all patients. On the evening before surgery, the visual analogue scale (VAS) Scoring was explained to all patients.

Design of Study

All the included patients were categorized into three groups viz.

Group A: Received 20ml of 0.2% Ropivacaine + 2ml of Normal Saline (total 22ml).

Group B: Received 20ml of 0.2% Ropivacaine + 0.25mcg/kg of Dexmedetomidine diluted in 2ml of Normal Saline (total 22ml).

Group C: Receiving 20ml of 0.2% Ropivacaine + Fentanyl 1mcg/kg diluted in 2ml of Normal Saline (total 22ml).

Exclusion Criteria

known allergy to any of the study drugs patients on recent oral opioids in the last 3 months pregnancy patients in whom the nerve block could not be performed as per the methodology.

Patients having any cognitive dysfunction patient with severe peripheral vascular and neurological disease

Anaesthetic Technique

All patients were premedicated with oral diazepam (10mg) administered on the night prior to surgery as night sedation. On the day of surgery, all patients were premedicated with injection pantoprazole 40mg i/v and injection midazolam 1mg i/v in the holding up area before transferring the patients to operating room and baseline hemodynamic parameters viz. HR, SpO2, NIBP and ECG (Standard chest leads) were recorded.

All patients were anesthetized using a Standardized Subarachnoid block (SAB) by injecting 3.5ml of 0.5% Bupivacaine in L3-4 space through 25G quinkes spinal needle in sitting position. After confirming the level of block, the patients were handed over to surgical team and hemodynamic parameters were recorded at specified time intervals.

After completion of surgery patients received Adductor Canal Block (ACB) for post-operative analgesia using ultrasound guided technique. Postoperative analgesia was assessed using Visual Analogue Scale (VAS) of 0 to 10 with (0 = no pain) and (10 = worst imaginable pain). Patients were assessed 2 hourly for first 12 hours post operatively and then 4 hourly upto 24 hours. Rescue analgesia using Tramadol 1mg/kg (i/v) was administered anytime the VAS was found ≥3. Sedation score was assessed by using Ramsay Sedation Score (RSS).

Frequency and total dose of rescue analgesia received and side effects such as nausea and vomiting were recorded over the 24 hour period. Vital signs viz. HR, NIBP, SpO2 and ECG were continuously monitored and recorded on two hourly basis for 12 hours post operatively and then 4 hourly upto 24 hours.

Statistical Methods

The recorded data was analyzed by using Statistical software SPSS (version 20.0). Continuous variables were expressed as Mean±SD and categorical variables were summarized as percentages. Student's independent t-test and Chi-square test were used. P value was taken less than or equal to 0.05 ($p \leq 0.05$) for significant differences.

Results

Age distribution in Group A was 19-72 years with mean of 47.4+15.98, Group B was 18-72 years with mean of 46.9+17.46 and in Group C was 21-74 years with mean of 49.2+15.69 respectively. The mean age among the three groups was comparable (p value - 0.836) with a statistically insignificant difference (table 1) (figure 1).

Among all the patients studied 53.13% were males and rest females 46.87%. As far as gender distribution was concerned among three groups it was statistically insignificant (p value-0.971) (table 2).

Among the groups observed majority of the patients were ASA I with 86.2% in group A, 85.3% in group B and 83.9% in group C (p value 0.968) with an insignificant statistical difference (table3).

Average duration of surgery in group A was 72.3+16.62minutes, group B was 71.2+14.67minutes and group C was 73.9+14.07 minutes. (pvalue-0.77) with an insignificant statistical difference (table 4).

Visual analogue scale was found highest in group A and lowest in group C. Median VAS score of group C was statistically lower than median VAS score of group B and median VAS score of group B was statistically lower than group A. VAS was monitored postoperatively at 0 hours, 2 hours, 4 hours, 6 hours, 8 hours, 10 hours, 12 hours, 16 hours, 20 hours. (p value <0.001) (table 5A & 5B)

On comparing the duration of analgesia among various groups it was found that in Group A was 4.3±1.70 hours, Group B was 5.4±1.52 hours and Group C was 7.6±1.20 hours. Mean duration of analgesia was statistically significantly longer in Group C and Group B as compared with Group A. Mean duration was longest in Group C followed by Group B and it was least in Group A. (p value<0.01) (table 6).

Total consumption of analgesia (IV Tramadol) in 24 hours in Group A was 200±28.76mg, Group B was 142±41.53mg and Group C was 108.9±30.64mg. The difference in total analgesic consumed among the three groups during 24 hours was statistically significant. Total quantity of analgesia required was significantly less in Group C, followed by Group B and was maximum in Group A among the three study groups. (P value<0.001) (table 7).Majority of patients in the three study groups showed no side effects to either drug or to block technique.3.4% of patients in Group A had nausea.3.2% patients in Group C had vomiting. Bradycardia was noted in 3.4% in Group A, 5.9% in Group B and 3.2% in

Group C. 2.9% patients had hypotension in Group B while as 3.2% patients had hypotension in Group C. The results were statistically insignificant (p value >0.05) (table 8).

Table 1: Age distribution of study patients among various groups

Group	No. of Cases	Mean Age (years)	SD	Range	P-value
Group A	29	47.4	15.98	19-72	0.836
Group B	34	46.9	17.46	18-72	
Group C	31	49.2	15.69	21-74	

Table 2: Gender distribution of study patients

Gender	Group A		Group B		Group C	
	No.	%age	No.	%age	No.	%age
Male	15	51.7	18	52.9	17	54.8
Female	14	48.3	16	47.1	14	45.2
Total	29	100	34	100	31	100
	Chi-square=0.061; P-value=0.971 (Not significant)					

Table 3: ASA status of study patients in various groups

ASA Status	Group A		Group B		Group C	
	No. of Patients	%age of Cases	No. of Patients	%age of Cases	No. of Patients	%age of Cases
ASA I	25	86.2	29	85.3	26	83.9
ASA II	4	13.8	5	14.7	5	16.1
Total	29	100	34	100	31	100
Chi-square=0.066; P-value=0.968						

Table 4: Showing average duration of surgery (minutes) in various groups

Group	No. of Patients	Mean duration of Surgery (min)	SD	Range (min)	P-value
Group A	29	72.3	16.62	55-115	0.772
Group B	34	71.2	14.67	55-110	
Group C	31	73.9	14.07	60-120	

Table 5A: Comparison based on postoperative VAS score among various groups

Time Interval	Group A		Group B		Group C		P-value
	Mean (VAS)	SD	Mean (VAS)	SD	Mean (VAS)	SD	
0 Hour	1.34	0.61	0.88	0.69	0.06	0.25	<0.001*
2 Hour	2.45	1.57	1.74	0.79	0.52	0.51	<0.001*
4 Hour	3.66	1.29	2.56	1.65	0.87	0.88	<0.001*
6 Hour	2.51	1.54	3.35	1.32	2.23	1.41	<0.001*
8 Hour	2.72	2.04	2.21	1.43	2.89	1.83	0.245
10 Hour	3.46	1.73	2.24	1.52	0.92	1.39	<0.001*
12 Hour	2.62	1.62	2.41	1.40	1.81	1.54	0.144
16 Hour	2.78	1.08	2.14	1.83	1.87	1.62	0.045
20 Hour	3.31	1.77	1.71	1.92	1.32	1.69	<0.001*
24 Hour	0.82	0.77	0.68	0.59	0.54	0.51	0.229

Table 5B: Intergroup comparison based on VAS score among various groups

Time Interval	P-value		
	A vs B	A vs C	B vs C
0 Hour	0.001*	<0.001*	<0.001*
2 Hour	0.008*	<0.001*	<0.001*
4 Hour	0.005*	<0.001*	<0.001*
6 Hour	0.021*	0.467	0.002*
8 Hour	0.244	0.736	0.103
10 Hour	0.004*	<0.001*	0.002*
12 Hour	0.783	0.072	0.111

16 Hour	0.103	0.014*	0.532
20 Hour	0.001*	<0.001*	0.389
24 Hour	0.417	0.102	0.312

Table 6: Comparison based on duration of analgesia (hours) among various groups

Groups	Mean (Hours)	SD	95% CI	Range	Comparison	P-value
Group A	4.3	1.70	3.70-4.99	2-6	A vs B	0.005*
Group B	5.4	1.52	4.88-5.94	4-8	B vs C	<0.001*
Group C	7.6	1.20	7.17-8.05	6-10	A vs C	<0.001*

Table 7: Comparison based on total analgesic (IV Tramadol) consumption (mg) among various groups

Groups	Mean (mg)	SD	95% CI	Range	Comparison	P-value
Group A	200.2	28.76	189.2-211.1	156-300	A vs B	<0.001*
Group B	142.7	41.53	128.2-157.2	58-204	B vs C	<0.001*
Group C	108.9	30.64	97.7-120.1	58-140	A vs C	<0.001*

Table 8: Comparison based on side effects among various groups

Side effects	Group A		Group B		Group C		P-value
	No.	%age	No.	%age	No.	%age	
Nausea	1	3.4	0	0.0	0	0.0	0.364
Vomiting	0	0.0	0	0.0	1	3.2	0.364
Bradycardia	1	3.4	2	5.9	1	3.2	0.769
Hypotension	0	0.0	1	2.9	1	3.2	0.599

Discussions

Arthroscopic knee surgery refers to a large variety of surgical interventions in the knee, and numerous analgesic regimens have been tried in order to find best combination of analgesics for these procedures. The postoperative pain response depends on the type and duration of surgical intervention [22]. The postoperative pain of knee arthroscopy can affect early ambulation, range of movement and duration of hospital stay. Adequate analgesia with motor preservation has become the goal after knee arthroscopies to enable shorter hospital stay, early physiotherapy, and faster recovery.

Adductor Canal Block (ACB) is a highly successful approach to the saphenous nerve, that was first described by Vander Wal [20]. In recent years adductor canal block has been introduced as a pure sensory nerve block for postoperative analgesia following knee surgeries. The rationale behind the ACB is that saphenous nerve (sensory nerve) and a part of obturator nerve are travelling through the adductor canal of thigh, so injecting local anesthetic in the adductor canal will provide adequate analgesia by blocking these nerves [24]. ACB also has an advantage of minimally effecting or preserving quadriceps strength [4,25].

Therefore, preserving quadriceps strength will facilitate early ambulation and postoperative rehabilitation. This can be achieved by the ultrasound guided ACB administered immediately after surgery before the effect of spinal anaesthesia wears off [26].

In our study we have used local anesthetic ropivacaine (0.2%, 20ml). Since it is lipophilic and therefore is less likely to penetrate large myelinated motor fibres [27]. Hence theoretically it has lesser motor blockade in ACB, so it is hypothesised that it will facilitate early ambulation after surgery. Our hypothesis is supported by Manisha et al (2020) in a study who used (0.5% ropivacaine 30 ml) [28] for ACB.

In our study we have used adjuvants dexmedetomidine and fentanyl in order to prolong the duration of analgesia, and reduce the total dose of rescue analgesia. Murphy et al. and Brummett et al in their studies on administration of dexmedetomidine as an adjuvant to local anesthetics reported that the mechanism of the analgesic effect of dexmedetomidine is still not clear and may be multifactorial [29,30]. Possible mechanism of action of dexmedetomidine is that it induces vasoconstriction through an action on α2 adrenoceptors or it produces analgesia peripherally by reducing norepinephrine release and increasing the potassium conduction in C and A-delta neurons responsible for passage of pain stimulus, whereas it produces analgesia and sedation centrally by inhibition of substance P release in the nociceptive pathway at the level of the dorsal root ganglia and locus ceruleus [31,32,33] as hypothesized mechanisms explained by Lee et al. (2016), Talke et al. (2003), and Yoshitomi et al. (2008) in their studies.

Rajkhowa et al. (2016) proposed that the mechanism of fentanyl in prolongation of analgesia may be due

to the existence of peripheral functional opioid receptors, but the existence of opioid receptor in peripheral tissue is still doubtful.[15] Furthermore, Rajkhowa et al. mentioned in their study that fentanyl used with ropivacaine prolonged the duration of sensory and motor blockade, probably by directly binding with opioid binding sites on the dorsal nerve roots aided with these axonal transports or by diffusing into surrounding tissues and subsequently into the epidural and subarachnoid spaces; it may also have a central opioid receptor mediated action after systemic absorption of fentanyl [34].

Taking all this into consideration about dexmedetomidine and fentanyl, we conducted an observational study in which we compared 0.2mcg/kg of body weight dexmedetomidine and 1mcg/kg of body weight fentanyl as an adjuvant to ropivacaine in ACB, with patients who received only 0.2% of ropivacaine (20 ml) in ACB. The various parameters we studied were duration of post-operative analgesia among the three groups, amount of rescue analgesia consumed, postoperative hemodynamic parameters and any adverse effects during postoperative period.

1. Duration of Analgesia

In our study we found that the mean duration of postoperative analgesia was 4.3±1.70 hours in Group A (Ropivacaine alone group), 5.4±1.52 hours in Group B (Ropivacaine + Dexmedetomidine) and 7.6±1.20 hours in Group C (Ropivacaine + Fentanyl). Difference in duration of analgesia among three groups was compared, it was found to be statistically highly significant. Duration of analgesia was longer in Group B than in Group A and was statistically significant ($p<0.005$ A vs B) and duration was also longer in Group C than in Group B ($p<0.001$ B vs C). So there was statistically significant difference in analgesia among adjuvant groups as compared to plain ropivacaine and among adjuvant groups Group C was longer.

Our results as far as using dexmedetomidine as adjuvant are similar with the results Goyal R et al (2017) [35]who conducted a study on adductor canal block analgesia after bilateral total knee replacement, they found an increased duration of analgesia on using dexmedetomidine as adjuvant. Duration was more prolonged in the group containing 0.5mcg/kg dexmedetomidine as an additive when compared with group containing 0.25mcg/kg dexmedetomidine as additive.

2. Visual Analogue Scale and total Analgesia consumption in 24 Hours:

In our study, the visual analogue scale (VAS) was lowest and statistically significant in patients who received fentanyl (1mcg/kg) as adjuvant to ropivacaine as compared to patients who received dexmedetomidine (0.2mcg/kg) as adjuvant and was highest among three groups in patients who received plain ropivacaine only. Total analgesic consumption of (injection tramadol 1mg/kg, i/v) in 24 hours postoperatively was 200±28.76 mg in Group A, 142±41.53 mg in Group B, 108±30.64 in Group C. Difference in analgesic consumption in 24 hours was statistically significant between Group A, Group B and Group C (P value < 0.001). Analgesic consumption was maximum in Group A, lower in Group B and least in Group C. Goyal R et al (2017) [35] conducted a study on Adductor canal block for post-operative analgesia after simultaneous bilateral total knee replacement using dexmedetomidine as an adjuvant to local anesthetic. In their study, they found that the total analgesia consumption was lower in patient receiving 0.5mcg/kg of dexmedetomidine as compared to group which received 0.2mcg/kg.

3. Baseline / Post Operative Hemodynamic Parameters

The baseline heart rate was 91.310±8.665, 92.206±8.654 and 88.16±9.494 per minute in Group A, B and C respectively. The mean heart rate was comparable and no statistical difference was found among the three groups at different time interval after the surgery (p value >0.05) The baseline systolic blood pressure was 124.7±11.688, 124.8±10.173 and 125.4±9.629 per mm of Hg in Group A, B and C respectively. The postoperative systolic blood pressure was comparable with no statistically significant difference among the three groups at different time interval after the surgery (p value >0.05). The baseline diastolic blood pressure was 78.241±7.366, 77.059±5.825 and 78.613±6.500 per mm of Hg in Group A, B and C respectively. The postoperative diastolic blood pressure was comparable with no statistically significant difference among the three groups at different time interval after the surgery (p value >0.05).

On comparing the mean arterial blood pressure in subjects of all the three groups at baseline, it was comparable with no statistically significant difference among the three groups at different time interval after the surgery (p value >0.05)

On comparing the mean SpO_2 in subjects of all the three groups, baseline was comparable during the postoperative period, we found no significant difference among the three groups (p value >0.05). Goyal R et al in 2017 in their study also found that heart rate, blood pressure, SpO_2 were comparable between the groups 0.5mcg/kg and 0.2mcg/kg of dexmedetomidine when added as an adjuvant.

4. Post Operative Complications

Majority of patients in the three study groups showed no side effects to either drug or to block technique. 3.4% of patients in Group A had nausea.

3.2% patients in Group C had vomiting. Bradycardia was noted in 3.4% in Group A, 5.9% in Group B and 3.2% in Group C. 2.9% patients had hypotension in Group B while as 3.2% patients had hypotension in Group C. The results were statistically insignificant (P value >0.05). Similar results were observed by Abdulatif M. et al in 2016 [36]. While comparing 25 mcg, 50 mcg or 75 mcg of dexmedetomidine, as an adjuvant to ropivacaine he also observed that the episodes of hypotension were significantly more common in the 75 mcg Group compared with the other three groups (p = 0.002).

Conclusions

The present study concluded that the addition of fentanyl and dexmedetomidine to ropivacaine for adductor canal block increases postoperative analgesia time and reduces total amount of analgesic consumed postoperatively.

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