Section: Anaesthesia

Original Research Article

COMPARATIVE EVALUATION OF DEXMEDETOMIDINE AND TRAMADOL FOR ATTENUATION OF POST- SPINAL ANAESTHESIA SHIVERING DURING LOWER LIMB SURGERIES: A RANDOMIZED DOUBLE-BLINDED STUDY

Praveen Kumar D P[1], Nusrat Anjum[2], Kailash Reddy[3]

[1]*Senior Resident, Department of Anaesthesia, Kidwai Memorial Institute of Oncology, Bengaluru, India.*
[2]*Assistant Professor, Department of Anaesthesia, Gulbarga Institute of Medical Sciences, Kalaburagi, India.*
[3]*Senior Resident, Department of Anaesthesia, ESIC Medical College, Kalaburagi, India.*

Received *: 07/07/2025*
Received in revised form *: 05/08/2025*
Accepted *: 10/08/2025*

Corresponding Author:
Dr. Praveen Kumar D P
Senior Resident, Dept of Anaesthesia, Kidwai Memorial Institute of Oncology, Bengaluru, India.
Email: praveenp49@gmail.com

DOI: 10.70034/ijmedph.2025.4.105

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2025; 15 (4); 585-590

ABSTRACT

Background: Spinal anesthesia is a common regional anaesthetic technique used for various surgical procedures, both planned and urgent. Post-spinal anaesthesia shivering is a frequent complication that can cause discomfort for patients and lead to increased oxygen consumption, elevated carbon dioxide levels, lactic acid buildup, and difficulty in patient monitoring. **Objective:** To compare the efficacy of IV Dexmedetomidine (0.5mcg/kg) and IV Tramadol (0.5mg/kg) for prevention of intraoperative shivering in patients undergoing lower limb surgeries under spinal anaesthesia.

Materials and Methods: In our randomized double blind comparative study (August 2022-January 2024), 100 patients aged between18-60 years of ASA 1 and 2 undergoing elective lower limb surgeries were given subarachnoid block (spinal anaesthesia), once the patient develops shivering they are allocated to either group A or B according to computer generated random number table and receive intravenous Dexmedetomidine 0.5µg/kg(study drug) in 100 ml normal saline and intravenous Tramadol 0.5mg/kg(control drug) in 100 ml normal saline for 10 minutes respectively. Onset of shivering, intensity of shivering and duration of shivering were recorded.

Results: In our study, dexmedetomidine (0.5mcg/kg) intravenous has better response rate compared to tramadol (0.5mg/kg) that is 2.76 ± 0.89 Mean ± SD and 3.98 ± 1.42 Mean ± SD respectively, Group-A (dexmedetomidine) had the mean intra-operative shivering score ranging from 0 to 0.32. and in Group-B (tramadol) had the mean intra-operative shivering score in the range of 0 to 2.00.

Conclusion: Intravenous dexmedetomidine is more effective in controlling shivering in view of fast onset of action and less recurrence rate than tramadol.

Keywords: Dexmedetomidine, Tramadol, Post- Spinal Anaesthesia, Shivering

INTRODUCTION

Spinal anaesthesia is type of regional anesthesia widely used as a safe anaesthetic technique for both elective and emergency procedures. Spinal anaesthesia produces vasodilatation, which facilitates core-to-peripheral redistribution of heat.[1] Shivering is one of the most common complications of Spinal anaesthesia due to impairment of thermoregulatory control. It was accounted that 19%-33% of the patients undergoing surgery under spinal anaesthesia experience shivering.[2]

Shivering is an involuntary, oscillatory muscular activity of skeletal muscles that augments metabolic heat production.[3] Various mechanisms have been implied for post anesthesia shivering. These are due to intraoperative heat loss, postoperative increased sympathetic tone, pain and, abnormal heat loss due to vasodilatation, and rapid intravenous (IV)

infusion of cold fluids. Shivering may also lead to patient discomfort, surgeon discomfort, impede monitoring techniques, increase intraocular and intracranial pressures, double or even triple oxygen consumption and carbon dioxide production etc.[4]

The treatment of shivering includes both pharmacological and non- pharmacological methods. Pharmacologic agents like fentanyl, tramadol, meperidine, nefopam, ketamine,[5] and α-2 agonists like clonidine and dexmedetomidine. The non- pharmacological management is by external heating like the use of forced-air warming blankets and warm-water blankets, heated humidification of inspired gases, warming of intravenous fluids, and increasing ambient operating room temperature. space blankets etc.[5,6]

Tramadol hydrochloride, a centrally acting analgesic drug, is effective in the treatment of post-anaesthetic shivering after general and neuraxial anaesthesia. It also inhibits the neuronal reuptake of noradrenaline and 5-hydroxytryptamine (5-HT), facilitates 5-HT release and activates the μ-opioid receptors and intravenous tramadol effectively controls shivering. The prominent side effects are nausea and vomiting.[7] Dexmedetomidine, a potent alpha 2A-adrenergic receptor agonist, has been used as a sedative agent and is known to reduce the shivering threshold.[8]

Hence, this study was conducted to evaluate the efficacy of the Dexmedetomidine and Tramadol drugs in prevention of shivering intraoperatively.

MATERIALS AND METHODS

This prospective Randomized double blinded study was conducted among all consenting patients scheduled for lower limb surgeries under spinal anaesthesia, in the Department of Anaesthesiology, at Gulbarga Institute of Medical Sciences Hospital, Kalaburagi. Study population was 100. Duration of study was 18 months (August 2022 to January 2024)

Sample Size

Based on the study conducted Kundra T S, et al (2017) 4, we considered the mean difference for the time to cessation of shivering between dexmedetomidine (D) and tramadol (T) group as 10 seconds with a standard deviation of 15 and 23. The sample size was calculated with 80% power and alpha of 0.05 (95% confidence interval), Applying the formula for a two-sided study: n (size per group) $=2c/\delta 2 + 1$ where, $\delta = (\mu 2 - \mu 1)/\sigma$ is the standardized effect size μ1 and μ2 are the means of the two treatment groups σ is the common SD c = 7.9 for 80% power Hence, n = 2 × 7.9/ (1/1.69) 2 + 1 = **46.1**. Rounding off, we took the sample size as **50** per group. The sample size thus calculated was found to be **100** with 50 cases in each group.

Inclusion Criteria

1. Patients aged between 18 to 60 years both male and female undergoing elective lower limb surgeries under spinal anaesthesia and reported shivering during surgery.
2. Belonging to American Society of Anaesthesiologists (ASA) Physical status I and II.
3. Patients whose BMI is in the range of 18 - 34.9.
4. Patients who are willing to give consent to be a part of the study.

Exclusion Criteria

1. Patients who do not develop shivering during surgery.
2. Patients with contraindications to regional anaesthesia.
3. Patients with history of hypersensitivity to amide local anaesthetics, dexmedetomidine and tramadol in the past.
4. Patients who have gone for complications during surgery like shock and prolongation of surgery more than 3 hrs.
5. Failure to decrease the shivering after repeated dosage more than 2 times.
6. Pregnant and lactating females.
7. Patients with hyperthyroidism, moderate to severe cardiopulmonary disease, hepatic failure psychiatric illness, renal failure, uncontrolled diabetes with autonomic neuropathy, severe bradycardia and hypotension.
8. Excessive hemorrhage needing transfusion.
9. Failure or incomplete spinal block.
10. Those with a known history of substance abuse.

Methods of Collection of Data

Institutional Ethical committee approval will be obtained prior to the commencement of the study. Informed written consent will be obtained from all the patients and are explained about that she/he is a part of study, following which detailed pre anaesthetic check up will be done according to the standard protocol. All patients will be monitored during surgery and screened for development of shivering intraoperatively till the sample size of 100 patients reached. The patients who develop shivering during surgery will be allocated to either of the groups (A or B) according to the computer generated random number table. As per the allocation, Group A patients will receive intravenous Dexmedetomidine 0.5μg/kg (study drug)in 100 ml normal saline and Group B will receive intravenous Tramadol 0.5mg/kg(control drug)in 100 ml normal saline for 10 minutes after administration of spinal anaesthesia.

Anaesthesiology resident (observer 1) who will prepare the study drug and control drug for administration will not be involved later in the study. Upon patient arrival in the anaesthesia room, 18-gauge intravenous cannula will be inserted and fixed in the upper limb. Patients will be then preloaded with lactate Ringer's solution. Fluids will be stored at room temperature. Basicmonitoring, including noninvasive blood pressure, electrocardiography and pulse oximetry will be connected for all patients and baseline values will be recorded.

Anaesthesiology resident (observer 2) who is blinded to the study drugs and contol drugs will perform spinal anaesthesia under aseptic technique at the L3–L4 or L4–L5 interspinous space using a 25-gauge spinal Quincke-tip needle. On confirming free flow of cerebrospinal fluid, injection bupivaciane 0.5% heavy 2.8 to 3.2 ml will be injected intrathecally. All patients will be turned to the supine position immediately and positioned for surgery ten minutes later.

Supplemental oxygen will be administered at the rate of 5-6 L/min via a face mask if necessary. The level of sensory block (defined as loss of pin-prick sensation), will be recorded every minute. Once the adequate levels are achieved and confirmed then surgery will be proceeded. The peak sensory block level will be recorded.

The temperature of the operating room and post anaesthesia-care unit will be kept at 22°C–26°C throughout the study. During the operation, the whole body of the patient, except the head, neck, and operation site, will be covered with one layer of surgical drapes.

Systolic, diastolic and mean arterial pressure, heart rate, oxygen saturation, time interval from spinal block to shivering occurrence, shivering score, sedation score, body temperature at the beginning and 0, 5, 10, 15,30 ,45 ,60 minutes and every half an hour thereafter till the end of surgery or till 180 mins will be observed and recorded.

The attending anesthesiologist would record:

1. The time at which shivering started after spinal anaesthesia (onset of shivering).
2. Severity of the shivering
3. Time to disappearance of shivering (in minutes) [Total duration of shivering]

The incidence of shivering will be assessed by close observation of the patients during the operation and in the post anaesthesia room. The intensity of shivering will be graded on a 5 point scale of 0 to 4 by the method of Crossly and Mahajan scale.

Crossly and Mahajan Scale,[9]

GRADE 0: No shivering GRADE 1: Piloerection or peripheral vasoconstriction, but no visible shivering GRADE 2: Muscular activity in only one muscle group

GRADE 3: Muscular activity in more than one muscle group, but not generalized; GRADE 4: Shivering involving the whole body.

The level of sedation will be assessed by means of modified Ramsay sedation scale

MODIFIED RAMSAY SEDATION SCALE,[10]

GRADE 1: Awake and alert, minimal or no cognitive impairment.

GRADE 2: Awake but tranquil, purposeful responses to verbal commands at conversation level.

GRADE 3: Appears asleep, purposeful responses to verbal commands at conversation level.

GRADE 4: Appears asleep, purposeful responses to verbal commands, but at louder than usual conversation level or requiring light glabellar tap.

GRADE 5: Asleep, sluggish purposeful responses to louder than usual conversation level or requiring strong glabellar tap.

GRADE 6: Asleep, sluggish purposeful responses only to painful stimuli

GRADE 7: Asleep, reflex withdrawal to painful stimuli only (no purposeful response) GRADE 8: Unresponsive to external stimuli including pain

Any patient complaining shivering of more than grade 2 will be treated with additional dose of Dexmedetomidine (0.5mcg/kg) or Tramadol (0.5mg/kg) in respective group and fluids will be transfused. Any adverse effects such as hypotension (defined asdecrease in mean arterial blood pressure of more than 20% from baseline), bradycardia (defined as decrease in HR <50 beats/min), nausea/ vomiting will be recorded.

Rescue drugs for hypotension, bradycardia, and nausea/vomiting will be intravenous atropine (0.6mg), vasopressors and then further infusion of crystalloid (300 mL) fluid as required, and ondansetron 4 mg IV, respectively and rescue drug for shivering will be intravenous injection pethidine (0.5mg/kg) and warm fluids when it recures for more than 2 times. The amount of rescue drugs in each group will be recorded and also the time for cessation, and failure of the drug will be recorded.

Statistical Analysis

Data was analyzed by IBM SPSS 25.0 version software. Collected data were entered in excel sheet and prepared master chart. Through the master chart, tables and graphs were constructed. For descriptive statistics were done mean, standard deviation initially; for quantitative data analysis independent samples “t-” test was used to compare the mean values between two variables for statistical significant. For qualitative data analysis chi- square test and Fisher exact probability tests were applied for statistically significant. P ≤0.05 was considered statistically significant for all comparison.

RESULTS

Double blind randomized trial controlled is carried out; random numbers are allotted all 100 patients. At the time of data analysis segregated two groups A and B.

Table 1: Groups wise distribution of cases

Groups	Number of cases	Percentage
Group-A: Dexmedetomidine	50	50.0
Group-B: Tramadol	50	50.0
Total	**100**	**100.0**

In the study; Out of 100 sample cases were divided in to two groups, Group-A = Dexmedetomidine were randomly divided 50 (50.0%) samples and Group-B = Tramadol were randomly divided 50 (50.0%) samples.

Table 2: Age wise distribution of cases

Age in years	Group-A (Dexmedetomidine)		Group-B (Tramadol)		Total	
	No.	%	No.	%	No.	%
18—30	12	24.0	10	20.0	22	22.0
31—40	15	30.0	13	26.0	28	28.0
41—50	16	32.0	15	30.0	31	31.0
51—60	7	14.0	12	24.0	19	19.0
Total	**50**	**100.0**	**50**	**100.0**	**100**	**100.0**
Mean ± SD	**38.80 ± 10.42**		**41.94 ± 11.39**		**40.37 ± 10.89**	
t-test & P-value	**t = 1.109**		**P = 0.308**		**NS**	

NS= not significant, S=significant, HS=highly significant

Study observes that, maximum number of patients in the two groups 31 (31.0%) cases were belongs to the age group of 41—50 years, followed by 28 (28.0%) were belongs to 31—40 years and 22 (22.0%) cases were belongs to the age groups of 18-30 years. But there was statistically
no significant difference of mean age between the groups Group-A and Group-B (P>0.05)
Study observed that; in the Group-A Male cases were 38 (76.0%) and in Group-B male cases were 36 (72.0%) and Female cases in Group-A were 12 (24.0%) and Group-B were 14 (28.0%). There was statistically no significant difference of distribution of gender between the Groups- D and Group-B (P>0.05).
The mean weight of Group-A was 63.20 kg and Group-B was 65.0 kg, mean weight was statistically not significant difference between Group-A and Group-B (P>0.05)
The mean height of Group-A was 164.54 cm and Group-B was 164.76 cm, mean height was statistically not significant difference between Group-A and Group-B (P>0.05)

Table 3: BMI wise comparison of cases between the groups

BMI kg/m^2	Categories	Group-A		Group-B	
		No.	%	No.	%
< 18.5	**Under weight**	1	2.0	2	4.0
18.5–24.9	**Normal weight**	27	54.0	24	48.0
25.0—29.9	**Over weight**	20	40.0	21	42.0
30—34.9	**Obesity**	2	4.0	3	6.0
≥ 35	**Obesity Class-I**	0	0.0	0	0.0
Total	**---**	**50**	**100.0**	**50**	**100.0**
Mean ± SD	**--**	**23.30 ± 4.75**		**24.22 ± 3.79**	

The mean BMI of Group-A was 23.30 and Group-B was 24.22, mean BMI was statistically not significant difference between Group-A and Group-B (P>0.05).

Table 4: ASA status wise distribution of cases in the groups

ASA status	Group-A		Group-B	
	No.	%	No.	%
I	23	46.0	20	40.0
II	27	54.0	30	60.0
Total	50	100.0	50	100.0
χ2 –Test value, P-value	**χ2 = 0.367,**	**P = 0.544,**	**NS**	

ASA status I in Group-A was 23 (46.0%) cases in Group-B were 20 (40.0%) cases. There was statistically not significant difference in the distribution of ASA status or grades between Group-A and Group-B (P>0.05).

Table 5: Comparison of duration of Surgery, Spinal anesthesia, Onset of shivering and Time for control of shivering after medication of cases between the groups

Duration of variables in minutes	Group-A Mean ± SD	Group-B Mean ± SD	t- test value	P value	significance
Duration of Surgery	68.46 ± 3.18	68.88 ± 2.37	**t = 0.748**	**0.456**	**NS**
Duration of Spinal anaesthesia	228.84 ± 9.01	229.40 ± 8.12	**t = 0.328**	**0.743**	**NS**
Onset of shivering	27.50 ± 3.21	28.26 ± 3.15	**t = 1.196**	**0.235**	**NS**
Time for control of shivering after medication	2.76 ± 0.89	3.98 ± 1.42	**t = 5.139**	**0.000**	**HS**

Study reveals that; The mean duration of surgery, Spinal anesthesia and onset of shivering observed higher in the Group-B as compare to Group-A which was statistically not significant (P>0.05)

The mean time of control of shivering after medication was observed significantly high in Group-B as compare to Group-A which was statistically highly significant (P<0.001).

Table 6: Comparison of Intra-operative sedation score between the Groups

Time interval	Group-A		Group-B		t-test value, P-value & Significance		
	Mean	SD	Mean	SD			
0 minutes	1.00	0.00	1.00	0.00	t = 0.000	P = 1.000	NS
1 minutes	1.00	0.00	1.05	0.28	t = 1.053	P = 0.304	NS
5 minutes	1.16	0.37	1.94	0.58	t = 3.718	P = 0.000	HS
10 minutes	1.08	0.27	1.92	0.56	t = 7.957	P = 0.000	HS
15 minutes	1.10	0.27	1.82	0.56	t = 9.450	P = 0.000	HS
30 minutes	1.14	0.35	1.52	0.51	t = 6.749	P = 0.000	HS
60 minutes	1.08	0.26	1.32	0.47	t = 4.373	P = 0.000	HS
90 minutes	1.00	0.00	1.02	0.14	t = 1.245	P = 0.108	NS
120 minutes	1.00	0.00	1.00	0.00	t = 0.00	P = 1.000	NS

Study observed that; Most of the patients in Group-A had the mean intra-operative sedation score ranging from 1 to 2. Similarly patients in Group-B had the mean intra-operative sedation score in the range of 1 to 1.94. The time duration mean sedation score values at 0 minute, 1 minutes, 90 minutes and 120 minutes observed equal or nearly equal in Group- A as compare to Group-B, which shows statistically not significant (P>0.05). Whereas The time duration mean values at 5 minutes, 10 minutes, 15 minutes, 30 minutes, and 60 minutes observed higher in Group-B as compare to Group-A, which shows statistically significant (P<0.05).

Table 7: Comparison of Intra-operative shivering score between the Groups A and Group B

Time interval	Group-A		Group-B		t-test value, P-value & Significance		
	Mean	SD	Mean	SD			
0 minutes	0.00	0.00	0.00	0.00	t = 0.000	P = 1.000	NS
1 minutes	0.08	0.27	0.16	0.37	t = 1.228	P = 0.222	NS
5 minutes	0.52	0.78	0.98	0.93	t = 2.657	P = 0.009	S
10 minutes	1.34	1.06	2.00	1.04	t = 3.126	P = 0.002	HS
15 minutes	1.32	0.93	2.00	0.94	t = 3.611	P = 0.000	HS
30 minutes	0.70	0.78	0.98	0.87	t = 1.041	P = 0.304	HS
60 minutes	0.48	0.40	0.74	0.94	t = 1.456	P = 0.149	HS
90 minutes	0.14	0.40	0.32	0.58	t = 1.675	P = 0.092	NS
120 minutes	0.08	0.27	0.14	0.35	t = 0.954	P = 0343	NS

Study observed that; Most of the patients in Group-A had the mean intra-operative shivering score ranging from 0 to 0.32. Similarly patients in Group-B had the mean intra- operative shivering score in the range of 0 to 2.00. The time duration mean sedation score values at 0 minute, 1 minutes, 30 minutes, 60 minutes, 90 minutes and 120 minutes observed higher in Group-B as compare to Group-A, which shows statistically not significant (P>0.05). Whereas The time duration mean shivering score values at 5 minutes, 10 minutes, and 15 minutes observed higher in Group-B as compare to Group-A, which shows statistically significant (P<0.05).

DISCUSSION

Lower abdominal and lower limb surgeries are usually done under spinal anaesthesia. The ease and safety profile compared with general anaesthesia makes spinal anaesthesia the procedure of choice whenever possible. Shivering is an unpleasant condition especially after a surgery. It increases intra ocular pressure, intracranial pressure, increase oxygen consumption, result in wound pain. The cause of shivering after regional anesthesia is not well known, but the probable causes could be decrease in core body temperature after sympathetic block; enhanced cutaneous blood flow, peripheral vasodilatation; which leads to increased heat loss through skin; rapid infusion of cold intravenous fluids; cold temperature of operation room; and cold anesthetic drugs stimulating thermosensitive receptors in the spinal cord. So shivering should be effectively controlled as fast as possible.

Our study was planned in a prospective, randomized double blind manner to study the efficacy of these two drugs in the prevention of shivering. The study was double blinded where in the patient and observer were blinded. In our study the sample size was calculated as 100 divided in to two groups, Group A and Group B were randomly divided 50 (50.0%) respectively, based on previous studies to obtain results of the study with a power of 90% and a significance level of 0.05.

Patients between the age of 18 and 60 with ASA I and II were selected for spinal anaesthesia. On analysing the demographic parameters, the distribution of age, gender, weight and height of the

patients in both the groups are compared and showed not significant results (P>0.05).

ASA physical status I in Group-A was 23 (46.0%) cases in Group-B were 20 (40.0%) cases. There was statistically not significant difference in the distribution of ASA status or grades between Group-A and Group-B (P>0.05).

The primary outcome measure studied was the ability of the drugs in the prevention of shivering among the study population. Among the drugs used in the study, dexmedetomidine was found to be superior to other drug in the prevention of shivering.

Study reveals that, the mean duration of surgery is 68.46 ± 3.18 mean ± SD in group A and 68.88 ± 2.37 mean ± SD in group B. Duration of spinal anaesthesia 228.84 ± 9.01 mean ± SD in group A and 229.40 ± 8.12 mean ± SD in group B observed higher in the Group B as compare to Group A which was statistically not significant (P>0.05). The mean onset of shivering 27.50 ± 3.21 mean ± SD in group A and 28.26 ± 3.15 mean ± SD in group B and time of control of shivering after medication was observed 2.76 ± 0.89 mean ± SD in group A and 3.98 ± 1.42 mean ± SD in group B significantly high in Group B as compare to Group A which was statistically highly significant (P<0.001).

When compared, our study has similar outcome to Lim fern et al where in both tramadol and pethidine group has similar response but statistically significant results when compared with dexmedetomidine group. The reason for this difference could have been because that study, given intervention was given after the commencement of shivering.[11]

When compared with Mittal et al study, which was a 2 drug comparison between dexmedetomidine and tramadol, showed that both drugs were equally effective but dexmedetomidine had a faster onset of action. Again, it was an intraoperative study where drugs were given after the onset of shivering.[5]

In Bozgeyik et al dexmedetomidine and tramadol were given along with a placebo element, both drugs were equally efficient in the prevention of shivering. The tramadol dose used in this study was 100 mg in all patients which could have been the cause for variation in the results.[12]

All the drugs used in the study for prevention of shivering can cause sedation to varying degrees. Study observed that, the patients in Group A had the mean intra- operative sedation score ranging from 1 to 2. Similarly patients in Group B had the mean intra-operative sedation score in the range of 1 to 2. The time duration mean sedation score values at 0 minute, 1 minutes, 90 minutes and 120 minutes observed equal or nearly equal in Group A as compare to Group B, which shows statistically not significant (P>0.05). Whereas The time duration mean values at 5 minutes, 10 minutes, 15 minutes, 30 minutes, and 60 minutes observed higher in Group-B as compare to Group-A, which shows statistically significant (P<0.05). Dexmedetomidine has a better sedation scale than tramadol when compared. Mittal et al concluded the study as sedation due to dexmedetomidine provides additional comfort to the patient5. Usta B et al,[13] study also, sedation scores were higher in dexmedetomidine group and was convincing for the patient.[74] The sedation score was higher in dexmedetomidine group starting from 5 minutes as observed in Bozgeyik et al is the similar result in our study too.[12]

CONCLUSION

In conclusion, drugs used in this study namely tramadol (0.5mg/kg) and Dexmedetomidine at 0.5µg/kg effectively used for control of post spinal anaesthesia shivering. Dexmedetomidine is more effective in the prevention of shivering when compared with tramadol. Dexmedetomidine has an added advantage of adequate reliable sedation without any respiratory depression. Dexmedetomidine better response rate and less recurrence when used. So, it can be used as a better alternative drug for shivering prophylaxis in patients undergoing surgeries under regional anaesthesia.

REFERENCES

1. Honarmand A, Safavi M. Comparison of prophylactic use of midazolam, ketamine, and ketamine plus midazolam for prevention of shivering during regional anaesthesia: a randomized double-blind placebo controlled trial. Br J Anaesth. 2008;101(4):557-62.
2. Aravind V, Dhakshinamoorthy M, Dhanosekaran C. A comparative study of clonidine & tramadol for the control of post spinal anaesthesia shivering. Int J Mod Res Rev. 2014 Oct;2(10):379-84.
3. Witte JD, Sessler DI. Perioperative shivering: physiology and pharmacology. Anesthesiology. 2002;96:467-84.
4. Kundra TS, Kuthiala G, Shrivastava A, Kaur P. A comparative study on efficacy of dexmedetomidine and tramadol on post-spinal anaesthesia shivering. Saudi J Anaesth. 2017;11:2-8.
5. Mittal G, Gupta K, Katyal S, Kaushal S. Randomised double-blind comparative study of dexmedetomidine and tramadol for post-spinal anaesthesia shivering. Indian J Anaesth. 2014;58:257-62.
6. Butterworth JF IV, Mackey DC, Wasnick JD. Morgan and Mikhail's Clinical Anaesthesiology. 5th ed. New York: LANGE; 2013. p. 1185.
7. Michael A Gropper et al, Miller's Anesthesia ,9th ed 2019;24;p.697,728
8. Flood P, Rathmell J, Shafer S. Stoelting's Pharmacology and Physiology in Anesthetic Practice. 5th ed. Philadelphia: Wolters Kluwer; 2015. p. 194-195.
9. Wang, J., Wang, Z., Liu, J. et al. Intravenous dexmedetomidine versus tramadol for treatment of shivering after spinal anesthesia: a meta-analysis of randomized controlled trials.BMC Anesthesiology 2020; 20:104 .
10. Klein RH, Alvarez-Jimenez R, Sukhai R, Oostdijk E, et al. Pharmacokinetics and pharmacodynamics of orally administered clonidine: a model-based approach. Horm Res Paediatr. 2013;79:300-9.
11. Lim F, Misiran K. Comparison of dexmedetomidine, pethidine, and tramadol in the treatment of post-neuraxial anaesthesia shivering. S Afr J Anaesth Analg. 2015;21(1):21- 6.
12. Bozgeyik S, Mizrak A, Kılıç E, Yendi F, Kaya Ugur B, et al. The effects of preemptive tramadol and dexmedetomidine on shivering during arthroscopy. Vol. 8, Issue 2, April- June 2014.
13. Usta B, Gozdemir M, Demircioglu RI, Muslu B, Sert H, Yaldiz A. Dexmedetomidine for the prevention of shivering during spinal anesthesia. Clinics (Sao Paulo) 2011;66:1187-91.