e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2023; 15 (12); 1570-1577

Original Research Article

Comparison between Dexmedetomidine, Ketamine and Tramadol for Prevention of Peri-Operative Shivering Among Patients under Spinal Anaesthesia

Bashishth Narayan[1], Rahul Rajan[2*]

[1]Assistant professor, Department of Anesthesia, Laxmi Chandravansi Medical College and Hospital
[2]Assistant professor, Department of Anesthesia, Gouri Devi Institute of Medical Sciences and Hospital

Received: 25-08-2023 / Revised: 28-09-2023 / Accepted: 30-10-2023
Corresponding author: Dr. Rahul Rajan
Conflict of interest: Nil

Abstract:

Introduction: Spinal anesthesia (SA) is the most common anesthesia administered for surgeries of lower limb, pelvis & lower abdomen. The most distressing & common complication observed is intra-operative shivering which can be avoided by various drugs, although none of them is the gold standard drug. So, this research was planned to compare the efficiency of three commonly used drug i.e. dexmedetomidine, tramadol and ketamine to prevent postspinal shivering during surgery.

Material and method: Our study was a double blinded randomized hospital based cross-sectional research. Subjects were randomly categorized into 3 groups having 35 subjects in each group receiving different study drugs. Study drug was administered just before SA. Preanaesthesia evaluation was done and standard anesthetic protocol was followed. Vitals, demographic variables, duration of surgery, mean axillary temperature (MAT), sedation and shivering incidence at different time intervals along with sedation grade and shivering grade of all the groups were noted and statistically analyzed. A 'p-value <0.05 was considered significant'.

Result: The mean age, gender distribution, ASA physical status, MAT and surgery duration was nearly equal among all the three groups with no statistical significant difference. Dexmedetomidine group showed significantly better sedation grade and non-significantly better grade of shivering than other groups. Adverse effects like nausea and vomiting were also not observed in dexmedetomidine group. Sedation was found to be significantly different among the 3 groups at almost all the time intervals except baseline and 120 minutes, whereas shivering was significantly different among 3 groups at 15 & 30 minutes.

Conclusion: Current study concludes that dexmedetomidine is much better than other drugs like tramadol and ketamine in managing shivering after SA. Additionally, dexmedetomidine has better sedation score and lesser side effects like nausea and vomiting compared to tramadol and ketamine.

Keywords: SA, Shivering, Dexmedetomidine, Ketamine, Tramadol etc.

Introduction

Spinal anesthesia (SA) is the most common anesthesia administered for surgeries of abdomen, pelvis and lower limb. The most distressing and frequent complication observed in SA is intra-operative shivering. Shivering is an involuntary repetitive action of skeletal muscles to increase the metabolic heat production. [1] When body temperature falls below the interthreshold range i.e. 36.5---37.5°C, then thermoregulatory natural defensive mechanism gets activated like shivering & vasoconstriction. Perioperative shivering has an extensive range of incidence from 40 to 70 % from the literatures after neuraxial anaesthesia. [2,3] The etiology of intra-operative shivering after SA is multifactorial. SA blunts thermoregulatory process by limiting vasoconstriction, leading in transfer of central heat from level of blockade to periphery. The neurological mechanism of shivering is mediated by spinal-motor neurons with preoptic region of anterior hypothalamus being the axis. This intraoperative shivering is an extremely distressing phenomenon causing physiological stress to the operating surgeon and perioperative physicians as well as to the patients. Due to this shivering, heat production is increased up to 600% and oxygen consumption increased up to 300%. This can result in metabolic abnormalities like hypercarbia, hypoxemia, increased intracranial and intraocular pressure, delay wound healing, lactic acidosis, increased wound pain and delay discharge from postanaesthetic care [4] leading to patient dissatisfaction and discomfort. [5] Shivering interferes with monitoring of vitals of the patients like ECG (electrocardiogram), BP (blood pressure),

oxygen saturation etc. and in the cardiac patients shivering compromises myocardial function also.
As postspinal shivering to the patients during surgery can be distressing and dangerous, the target must prevention rather than treatment.

By various existing pharmacological & non-pharmacological therapies, shivering can be avoided but none of them being the gold standard method. The non-pharmacologic therapies comprise covering the skin using external warmer, surgical drape, blood warmers, intravenous fluids, blankets etc. Throughout the surgery warm, humidified oxygen should be used via nasal prongs and irrigating solutions used for wound irrigation should have temperature near to human body. The pharmacological therapy includes different drugs to control perioperative shivering. Previously pethidine was extensively used to manage shivering as a drug of choice but these days many researchers are not using this due to its side effects. So, till now no single remedy has been found to be effectual with no associated side effects. It is believed that perioperative shivering involves various neuro-transmitter pathways of serotonergic, alpha2 adrenergic, opioids & anticholinergic receptor. So numerous other drugs like fentanyl, tramadol, physostigmine, ketamine, clonidine, dexmedetomidine, dexamethasone, clonidine etc. are used for prevention and management of post-spinal shivering. [6-11]

Out of all these drugs, tramadol are commonly used for perioperative shivering. During last decade, ketamine has grown as drug of choice and recently dexmedetomidine has gained the popularity. Tramadol modulates temperature regulation centre of humans by inhibiting uptake of noradrenaline and serotonin in the spinal cord and activates the release of hydroxyltryptamine. Ketamine is a competitive antagonist of N-methyl-d-aspartate (NMDA) receptor which inhibits uptake of norepinephrine in the postganglionic sympathetic nerve endings for thermoregulation.[12] Dexmedetomidine decreases vasoconstriction to reduce shivering threshold. Studies believe dexmedetomidine to be better than tramadol as it has fewer side effects like vomiting & nausea than tramadol.

Dexmedetomidine is also considered to be superior to ketamine as it offers improved sedation than ketamine. So dexmedetomidine manages shivering better than tramadol and ketamine with lesser side effects and higher sedation [13,14] Many studies are done on ketamine and tramadol but recently introduced drug dexmedetomidine has very few studies which compare it with either ketamine or tramadol. As dexmedetomidine has the advantage of more sedation than ketamine and lower incidence of nausea than tramadol, a study directly comparing dexmedetomidine with tramadol and ketamine is important. Hence, this research was planned to evaluate the efficiency of dexmedetomidine, tramadol and ketamine to prevent postspinal shivering during surgery.

Material and Method

Our study was a double blinded randomized hospital oriented cross-sectional research done on the patients visiting "Gouri Devi Institute of Medical Sciences and Hospital" for a period of around one year from November 2022 to October 2023 after attaining ethical clearance from institutional ethics committee. A total of 105 patients, planned for surgery under spinal anesthesia with age above 18 years having 'ASA (American Society of Anesthesiologists) physical status' I or II of both genders were enrolled in the study after getting informed consent. People with body mass index >30 kg/m^2, severe metabolic disorder, thyroid, cardiac, kidney or liver disease, pregnant & lactating females, body temperature above or below the interthreshold range, patients having contraindication to SA & 'visual analogue scale (VAS)' >6 were excluded. Computer generated random allocation of the participants to 3 groups was done using blinded opaque envelopes. GroupA received 0.5mg/kg tramadol, groupB received 0.25mg/kg ketamine and groupC received 0.5µg/kg dexmedetomidine. The study was a double blinded to the participants and the care providers. Preanaesthesia evaluation in detail was conducted for all the 3 groups. Procedure was explained to the patients and monitors were applied to note the baseline vitals like oxygen saturation level, ECG, BP, heart rate, respiratory rate, level of consciousness, temperature etc. at every 5minutes for first 30minutes and then after every 15minutes till 120 minutes.

A standardized hospital protocol of preoperative preparations including premedication and overnight fasting was followed for all the three groups. Operation theatre was set between 22°-25°C with all drugs and fluids maintained at room temperature and to control the temperature, patient's body parts were covered with a blanket or were draped in surgical drapes. A standard anaesthetic protocol of the hospital was followed for all the three groups. Ringer lactate solution was preloaded before SA at the rate of 10ml/kg/h to the subjects. Assigned study drug was administered as slow IV bolus to the patients just before i.e. around 5minutes prior to SA. In sitting position, maintaining all sterile conditions, skin infiltration with 2ml of 2% lignocaine was done. Epidural space between L3-L4 or L4-L5 was spotted using pinprick technique at midaxillary line by 25G quincke spinal needle and after clear aspiration of cerebrospinal fluid (CSF), intrathecal administration of 15mg '0.5% hyperbaric bupivacaine' was done at the pace of 0.2ml/sec over a time of 30seconds. The subjects

were geared up for surgery when T10 block level was attained. Patients were observed and baseline vitals were noted for 2hours or till the surgery.

Any adverse effects like nausea, vomiting, shivering etc. were recorded and managed with the appropriate drugs or therapies. Shivering was graded with a 'Wrench grade four point scale' [15] i.e. '0 shows no shivering, 1 shows piloerection or peripheral vasoconstriction or peripheral cyanosis but no visible shivering, 2 shows visible muscular activity limited to one muscle group, 3 shows visible muscular activity in more than one muscle group, 4 shows gross muscle activity in the form of whole body shivering'.

The level of sedation was seen by 'Filos et al. four-point ordinal scale'[16] i.e. '0 depicts awake and alert, 1 depicts drowsy and responsive to verbal stimuli, 2 depicts drowsy and responsive to physical stimuli, 3 depicts unarousable'. Peri-operative nausea and vomiting were graded using the 'four-point ordinal scale' i.e. '0 shows no nausea/vomiting, 1 shows nausea, 2 shows retching, 3 shows vomiting'.[16]

Observed data were noted and statistically analysed by 'statistical package for the social sciences (SPSS)' version 22.0. Baseline data were noted as mean±SD. Categorical & ordinal data were analyzed as percentages. Data collected and tabulated were analyzed using 'unpaired t-test, chi-square test and analysis of variance (ANOVA)', followed by 'Bonferroni's post hoc' test. 'p value less than 0.05 were considered as significant'.

Result

This study was done on of 105 patients, planned for surgery under SA. The subjects were categorized into 3 groups based on drug administered i.e. groupA received tramadol, groupB received ketamine and group C received dexmedetomidine before SA. Table 1 shows comparison of demographic and other variables among three groups. Group A patients were having mean age of 38.6±12.9years, in group B it was 40.2±13.1years and in group C 39.9±12.9years with no significant difference among them. Study showed male predominance.

Group A had maximum males i.e. 26 (74.28%) followed by 23 (65.71%) in group C and 21 (60.00%) in group B. Females were more in group B i.e. 14 (40.00%) trailed by group C with 12 (34.28%) and group A with 9 (25.71%). Study had maximum patients with ASA I in group C i.e. 27 (77.14%) followed by group A and B with 26 (74.28%). ASA II was observed in 9 (25.71%) patients in both group A and B followed by 8 (22.85%) in group C. Gender and ASA physical status had no significant statistical association with 3 different groups. Duration of surgery was non-significantly higher in group B i.e. 67.3±9.4minutes than group C (63.7±14.6minutes) and groupA (61.2±15.1minutes).

Table 1: Demographic and other variables among three groups

Variable		GroupA	GroupB	Group C	p-value
Age in yrs (Mean±SD)		38.6±12.9	40.2±13.1	39.9±12.9	>0.05
Sex n (%)	Male	26 (74.28%)	21 (60.00%)	23 (65.71%)	>0.05
	Female	9 (25.71%)	14 (40.00%)	12 (34.28%)	
ASA n (%)	I	26 (74.28%)	26 (74.28%)	27 (77.14%)	>0.05
	II	9 (25.71%)	9 (25.71%)	8 (22.85%)	
Surgery duration in minutes (Mean±SD)		61.2±15.1	67.3±9.4	63.7±14.6	>0.05

Figure 1 illustrates the mean axillary temperature (MAT) among the groups at different time intervals.

Group A showed 36.20, 36.17, 36.20, 36.02, 36.08, 36.12, 36.21, 36.11, 36.19, 36.30 and 36.39 MAT in degree centigrade, group B showed 36.28, 36.14, 36.21, 36.09, 36.02, 36.14, 36.12, 36.21, 36.33, 36.27 and 36.38 whereas group C showed 36.28, 36.14, 36.18, 35.97, 36.02, 36.17, 36.18, 36.27, 36.33, 36.27 and 36.33 degree centigrade MAT at baseline, 5, 10, 15, 30, 45, 60, 75, 90, 105 and 120 minutes respectively.

Although, difference of MAT among three groups was not statistically significant.

Figure 1: Comparison of mean axillary temperature in °C among the groups

Figure 2 depicts comparison of shivering grades among the groups.

Shivering grade 0 was seen in 15 (42.86%), 30 (85.71%) and 33 (94.28%) patients of group A, B and C respectively. Grade 1 shivering was observed in 5 (14.29%), 1 (2.86%) and 1 (2.86%) patients while grade 2 shivering was seen in 6 (17.14%), 3 (8.57%) and 1 (2.86%) cases of group A, B and C consecutively. Further grade 3 was observed in only 1 (2.86%) subject of group B and no patient of group B had grade 4 shivering.

In group A, grade 3 and 4 was seen in 5 (14.29%) and 4 (11.43%) respectively. In group C, none had grade 3 and 4 of shivering. The association of grade of shivering with different groups was found to be non-significant.

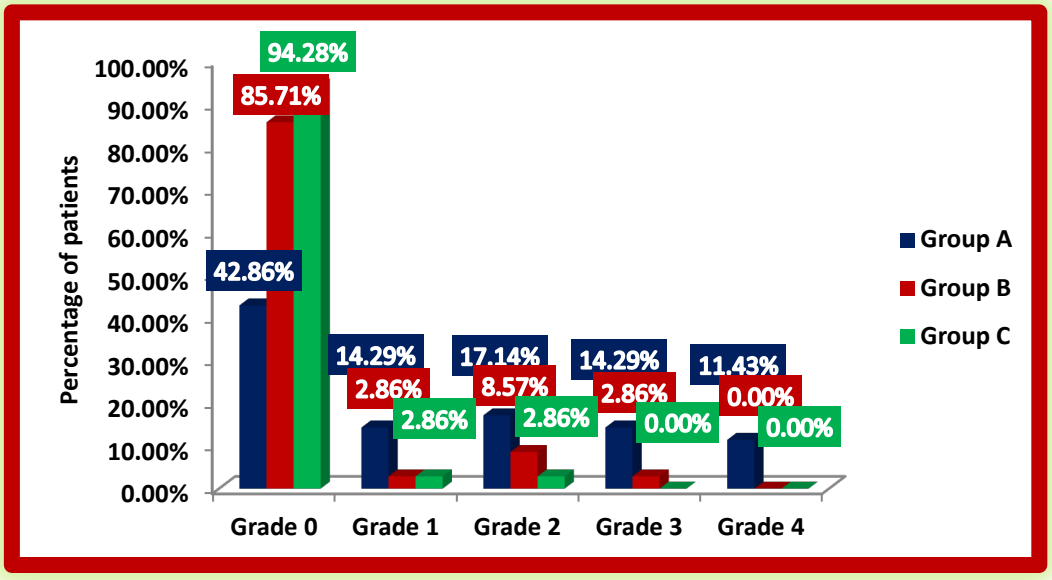

Figure 2: Comparison of shivering grades among the groups

Figure 3 illustrates assessment of sedation grades among the groups. Grade 0 was seen in 31 (88.57%), 29 (82.86%) and 30 (85.71%) whereas grade 1 was observed in 4 (11.43%), 6 (17.14%) and 5 (14.28%) cases of group A, B and C respectively. None of the patient from any of the three groups had grade 2 or 3. The association of grades of sedation with different groups were found to be significant.

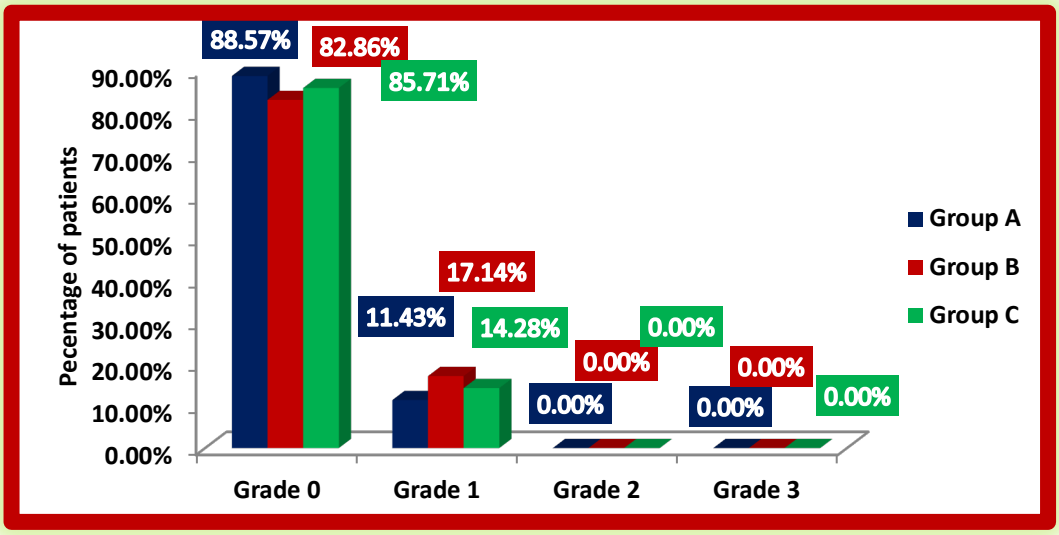

Figure 3: Comparison of sedation grades among the groups

Table 2 depicts distribution of patients based on shivering among three groups at different time intervals. Shivering was not observed in any of the group at baseline, 5, 10, 90 and 105 minutes. In group A, shivering was seen in 5 and 3 patients at 15 and 45 minutes respectively. At 30minutes, 10 group A patients and 3 group B patients had shivering. Whereas only 1 patient had shivering in group C at 30 and 45 minutes, in group B at 75 and 120 minutes and in group A at 60 and 75 minutes. Shivering was found to be significantly associated with the three groups at 15 and 30 minutes.

Table 2: Shivering among three groups at different time intervals

Time in minutes	GroupA	GroupB	GroupC	p-value
Baseline	0	0	0	0
5	0	0	0	0
10	0	0	0	0
15	5	0	0	**<0.05**
30	10	3	1	**<0.05**
45	3	0	1	>0.05
60	1	0	0	>0.05
75	1	1	0	>0.05
90	0	0	0	0
105	0	0	0	0
120	0	1	0	>0.05

Table 3 depicts distribution of patients based on sedation among three groups at different time intervals. Sedation was not seen in any of the group at baseline and 120 minutes and in group A and B at 5, 10 and 105 minutes. Group A had sedation in 3, 9, 9, 10, 7 and 5 patients at 15, 30, 45, 60, 75 and 90 minutes consecutively where as in group B it was found in 12, 15, 14, 10, 7 and 4 patients at the same time period. In group C, sedation was present in 17, 19, 19, 20, 20, 18 ,16, 15 and 9 patients at 5, 10, 15, 30, 45, 60, 75, 90 and 105 minutes respectively. Sedation was found to be significantly associated with the three groups at all the time intervals except at baseline and 120 minutes.

Table 3: Sedation among three groups at different time intervals

Time in minutes	GroupA	GroupB	GroupC	p-value
Baseline	0	0	0	0
5	0	0	17	**<0.05**
10	0	0	19	**<0.05**
15	3	12	19	**<0.05**
30	9	15	20	**<0.05**
45	9	14	20	**<0.05**
60	10	10	18	**<0.05**

75	7	7	16	**<0.05**
90	5	4	15	**<0.05**
105	0	0	9	**<0.05**
120	0	0	0	0

Figure 4 clearly shows that group C patients had no side effects. Nausea and vomiting was observed maximally in group A i.e. 5 (14.28%) patients followed by group B i.e. 3 (8.57%) cases.

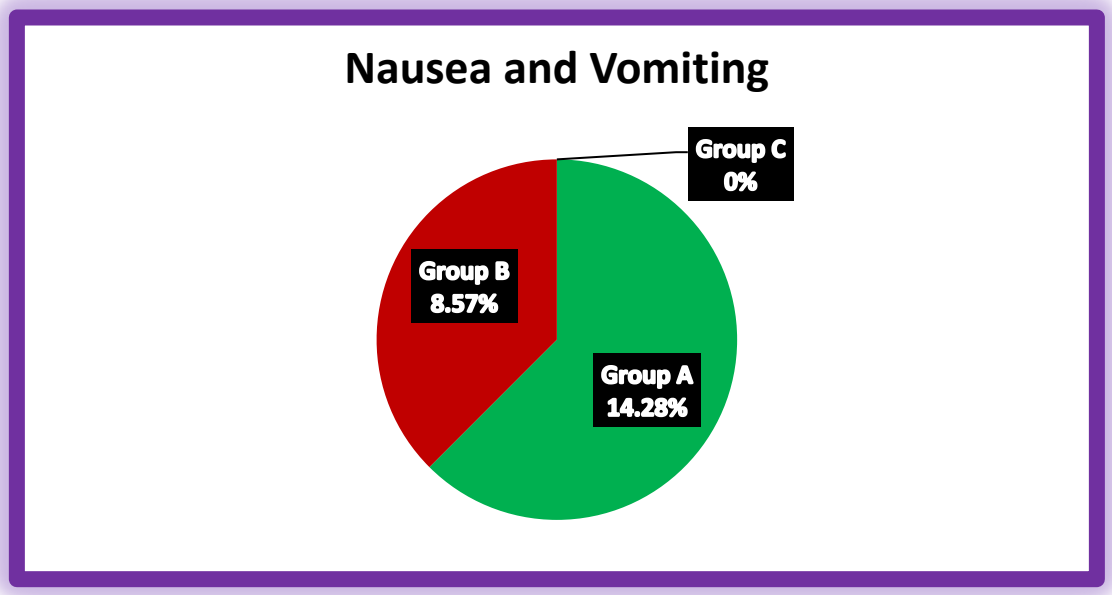

Figure 4: Distribution of patients based on nausea and vomiting

Discussion

Shivering is a common complication under SA happening either due to fall in temperature or misinformation from receptors of body. Several hypotheses have been anticipated to elucidate the reason of shivering after SA and various therapies and drugs are available of restricted use due to their side-effects. So this double blinded cross-sectional hospital based study was planned at 'Gouri Devi Institute of Medical Sciences and Hospital' on 105 patients. Patients were randomly divided into three groups each having 35 patients i.e. group A, B or C receiving different study drugs.

Our study showed non-significant predominance of males than females with comparable mean age and ASA physical status in all three groups. This finding is in accordance with the study by Tanwin Khan et al.,[17] Kumar RA et al.[18] and Ameta N et al.[19] Another study by R. Venkatraman et al.[20] had findings in contrast to our study as they observed dominance of female and ASA physical status II in their study. In current study surgery duration was also similar and no significant difference observed among the groups, which is supported by the study of Ameta N et al.[19] as they found nearly similar outcome in all the groups. Present study found no difference in MAT significantly among three groups at different time period which is in concordance with the outcome of study by Kumar RA et al. [18], Ameta N et al. [19] and R. Venkatraman et al. [20] Our study observed maximum adverse effects i.e. nausea and vomiting in tramadol group whereas dexmedetomidine group reported no nausea and vomiting at all.

In comparison to other groups, dexmedetomidine group had maximum patients with shivering grade 0 with no patient having grade 3 & 4. In dexmedetomidine group at different time intervals, shivering was seen in very few patients while maximum shivering patients were found in tramadol group. At 15 and 30 minutes, shivering was found to be significantly associated with the groups. Dexmedetomidine group also showed more number of patients with better sedation than ketamine followed by tramadol group at different time intervals and sedation was found to be significantly associated with the three groups at almost all the time intervals.

This finding of our study, dexmedetomidine being superior than other two drugs i.e. tramadol and ketamine is in harmony with the study by Tanwin Khan et al.[17] as they also found better shivering grade, RR, BP, HR and other parameters in dexmedetomidine group than other groups. Tanwin Khan et al. [17] also reported no nausea and vomiting in dexmedetomidine group which is similar to our findings. In contrast to our outcome, study by Sahi S et al.[21] observed significantly

low shivering, nausea and vomiting in tramadol group. In disagreement to our outcome, study by Bozgeyik S et al.,[22] and Mittal et al.[23] also found both drugs i.e. dexmedetomidine and tramadol to be equally effective in shivering with dexmedetomidine causing more sedation and faster onset of action.

Shivering and sedation score of present study presented dexmedetomidine as better drug which is in accordance with the study by Ameta N et al.[19] Another study by Houssein M & Ibrahim I,[14] also documented lesser shivering with more deep sedation after SA in dexmedetomidine group than ketamine. The sedation, shivering and MAT findings at different time intervals of our study are in harmony with the study by Kumar RA et al.[18] Study by Usta B et al. [24] and Elvan et al.[25] is in accord with our results as they found dexmedetomidine group to have superior sedation scores while maintaining tranquil state following oral commands.

A meta-analysis conducted by Wang J et al.[13] comparing dexmedetomidine and tramadol also concluded dexmedetomidine to be superior drug in managing shivering after SA than tramadol with low chances of its recurrence.

Conclusion

Our study concludes that dexmedetomidine is found to be better than tramadol and ketamine in managing shivering after SA. Additionally, dexmedetomidine has faster onset of action and better sedation score along with maintained consciousness. It has advantage of providing better hemodynamic parameters along with low clinical impact due to lesser side effects like nausea and vomiting compared to tramadol and ketamine. Sedation by dexmedetomidine along with a watch on hemodynamic parameters is comfortable for the patients as it maintains cardio-respiratory stability without any respiratory depression.

References

1. Lema GF, Gebremedhn EG, Gebregzi AH, Desta YT, Kassa AA. Efficacy of intravenous tramadol and low-dose ketamine in the prevention of post-spinal anaesthesia shivering following cesarean section: A doubleblinded, randomized control trial. International Journal of Womens Health. 2017;9:681-88
2. Esmat IM, Mohamed MM, Abdelaal WA, El-Hariri HM, Ashoor TM. Postspinal anaesthesia shivering in lower abdominal and lower limb surgeries: A randomized controlled comparison between paracetamol and dexamethasone. BMC Anaesthesiolgy. 2021;21(1):262.
3. Gupta P, Gupta M. Intrathecal tramadol for prevention of postanaesthesia shivering after subarachnoid block: A prospective randomized placebo-controlled comparison of two different doses (10 and 20 mg). Anaesthesia Essays and Researches.2018; 12 (2):495-500.
4. Lopez MB. Postanaesthetic shivering - from pathophysiology to prevention. Rom J Anaesth Intensive Care. 2018; 25:73-81.
5. Ferede YA, Aytolign HA, Mersha AT. The magnitude and associated factors of intraoperative shivering after cesarean section delivery under spinal anaesthesia. A cross sectional study. Ann Med Sur. 2021; 72:103022.
6. Tilahun A, Seifu A, Aregawi A, Abera B, Demsie DG. Effectiveness of meperidine versus tramadol on post spinal anaesthesia shivering in elective cesarean section: A prospective observational cohort study. Int J Sur. 2021; 28:22-26.
7. Panneer M, Murugaiyan P, Rao S. A comparative study of intravenous dexmedetomidine and intravenous clonidine for postspinal shivering in patients undergoing lower limb orthopedic surgeries. Anaesthesia Essays and Res. 2017; 11:151.
8. Botros JM, Mahmoud AMS, Ragab SG, Ahmed MAA, Roushdy HMS, Yassin HM, et al. Comparative study between dexmedetomidine and ondansteron for prevention of post spinal shivering. A randomized controlled trial. BMC Anesthesiology. 2018; 18(1); 179.
9. Nesioonpour S, Bayat S, Ghomeishi A, Behaeen K, Savaie M, Ahmadzadeh A, et al. Effect of intravenous dexmedetomidine on shivering in cesarean section under intrathecal anaesthesia: Randomized clinical trial. Anaesthesia Pain Medicine. 2022; 12(3):e122735.
10. Lamontagne C, Lesage S, Villeneuve E, Lidzborski E, Derstenfeld A, Crochetière C, et al. Intravenous dexmedetomidine for the treatment of shivering during Cesarean delivery under neuraxial anaesthesia: A randomized-controlled trial. Canadian J Anaesth. 2019; 66:762-71.
11. Sween LK, Xu S, Li C, O'Donoghue MA, Ciampa EJ, Kowalczyk JJ, et al. Low-dose intravenous dexmedetomidine reduces shivering following cesarean delivery: A randomized controlled trial. Int J Obstetric Anaesthesia. 2021; 45:49-55.
12. Thangavelu R, George S, Kandasamy R. Prophylactic low dose ketamine infusion for prevention of shivering during spinal anaesthesia: A randomized double blind clinical trial. J Anaesthesiol Clinical Pharmacology. 2020; 36:506-10.
13. Wang J, Wang Z, Liu J, Wang N. Intravenous dexmedetomidine versus tramadol for

treatment of shivering after spinal anaesthesia: A meta-analysis of randomized controlled trials. BMC Anesthesiol. 2020; 20(1); 104.
14. Houssein M, Ibrahim I. Intravenous low-dose ketamine injection versus dexmedetomidine infusion for prevention of intraoperative shivering during spinal anaesthesia. Ain-Shams Journal of Anaesthesiology. 2016; 9:524.
15. Wrench IJ, Singh P, Dennis AR, Mahajan RP, Crossley AWA. The minimum effective doses of pethidine and doxapram in the treatment of post-anaesthetic shivering. Anaesthesia. 1997:52(1):32-36
16. Filos KS, Goudas LC, Patroni O, Polyzou V. Hemodynamic and analgesic profile after intrathecal clonidine in humans: A dose-response study. Anesthesiology.1994; 81:591-01.
17. Tanwin Khan et al., Comparison between Dexmedetomidine, Ketamine and Tramadol for Prevention of Perioperative Shivering under Spinal Anaesthesia: A Randomised Clinical Trial, Journal of Clinical and Diagnostic Research. 2022 Dec, Vol-16(12): UC32-UC36, DOI: 10.7860/ JCDR/2022/ 59358.17368
18. Kumar RA, Ammu S. Comparing the efficacy of tramadol, ketamine and dexmedetomidine in the prevention of intraoperative shivering in patients undergoing surgery under subarachnoid blockade. Indian J Clin Anaesth 2021;8(3):446-451
19. Ameta N, Jacob M, Hasnain S, Ramesh G. Comparison of prophylactic use of ketamine, tramadol, and dexmedetomidine for prevention of shivering after spinal anesthesia. J Anaesthesiol Clin Pharmacol 2018;34:352-6
20. R. Venkatraman et al., A prospective, randomized, double-blinded control study on comparison of tramadol, clonidine and dexmedetomidine for post spinal anesthesia shivering, Rev Bras Anestesiol. 2018;68(1):42-48
21. Sahi S, Singh MR, Katyal S. Comparative efficacy of intravenous dexmedetomidine, clonidine, and tramadol in postanaesthesia shivering. Journal of Anaesthesiology and Clinical Pharmacology. 2016;32:240-44
22. Bozgeyik S, Mizrak A, Kiliç E, Yendi F, Ugur B. The effects of preemptive tramadol and dexmedetomidine on shivering during arthroscopy. Saudi J Anaesth. 2014; 8:238-43.
23. Mittal G, Gupta K, Katyal S, Kaushal S. Randomised double-blind comparative study of dexmedetomidine and tramadolfor post-spinal anaesthesia shivering. Indian J Anaesth. 2014;58:257–62
24. Usta B et al., Dexmedetomidine for the prevention of shivering during spinal anesthesia. Clinics (Sao Paulo). 2011; 66(7):1187–91.
25. Elvan EG, Qc B, Uzun S. Dexmedetomidine and postoperative shivering in patients undergoing elective abdominal hysterectomy. Eur J Anaesthesiol. 2008; 25:357–64.