

COMPARISON OF INTRATHECAL VERSUS INTRAVENOUS DEXMEDETOMIDINE ON PERIOPERATIVE SHIVERING, SEDATION AND HEMODYNAMIC PROFILE DURING SPINAL ANAESTHESIA FOR LOWER LIMB ORTHOPAEDIC SURGERIES

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ABSTRACT

Background: Spinal anaesthesia is commonly used for lower limb orthopaedic surgeries, but perioperative shivering, variable sedation, and hemodynamic fluctuations remain important concerns. Dexmedetomidine, administered either intravenously or intrathecally, may attenuate shivering, provide cooperative sedation, and influence cardiovascular stability. The aim and objective is to compare intrathecal versus intravenous dexmedetomidine during spinal anaesthesia for lower limb orthopaedic surgeries with respect to perioperative shivering, sedation, and hemodynamic profile. **Materials and Methods:** This prospective, randomized, double-blinded comparative clinical study included 90 ASA I and II patients aged 18 to 60 years undergoing elective lower limb orthopaedic surgeries under spinal anaesthesia. Patients were allocated into two groups of 45 each. Group A received intravenous dexmedetomidine 0.5 mcg/kg in 100 mL normal saline before spinal block, whereas Group B received intrathecal dexmedetomidine 5 mcg with 12.5 mg hyperbaric bupivacaine. Heart rate, systolic blood pressure, mean arterial pressure, Ramsay sedation score, shivering score, and ephedrine or atropine requirement were recorded and analyzed statistically. **Result:** Baseline demographic characteristics were comparable between groups. Heart rate, systolic blood pressure, and mean arterial pressure showed a greater reduction in the intravenous group at several intraoperative intervals, though adverse events were minimal. Sedation scores were comparable between groups. Shivering scores were significantly lower in the intravenous group during important intraoperative intervals, indicating superior shivering control. Ephedrine requirement was minimal and identical in both groups, and no patient required atropine. **Conclusion:** Both routes provided effective sedation with acceptable safety; however, intravenous dexmedetomidine offered better perioperative shivering suppression with manageable hemodynamic effects, making it preferable when shivering prevention is a priority. This advantage was especially evident during the early intraoperative period.

INTRODUCTION

Spinal anaesthesia is widely employed for lower limb orthopaedic surgeries owing to its simplicity, rapid onset, reduced airway manipulation, and favourable postoperative analgesic profile.^[1] However, despite these advantages, it is frequently associated with perioperative complications, among which shivering remains one of the most common

and clinically significant. The incidence of shivering following spinal anaesthesia has been reported to range from approximately 19% to 33%, reflecting its high prevalence in routine anaesthetic practice.^[2] This phenomenon is not merely uncomfortable but also physiologically stressful, as it increases oxygen consumption, carbon dioxide production, and metabolic demand, thereby potentially exacerbating

perioperative morbidity, especially in vulnerable patients.^[3]

The occurrence of shivering during spinal anaesthesia is primarily attributed to impairment of thermoregulation. Neuraxial blockade leads to vasodilation and redistribution of core heat to peripheral compartments, resulting in a reduction in core body temperature.^[4] Additionally, inhibition of central thermoregulatory control mechanisms further lowers the threshold for shivering.^[5] The involuntary muscular activity associated with shivering interferes with intraoperative monitoring, particularly electrocardiography and pulse oximetry, and may complicate surgical precision. Therefore, effective prevention and management of perioperative shivering constitute an essential component of anaesthetic care.^[6]

In recent years, pharmacological agents have been increasingly utilized to mitigate shivering, among which Dexmedetomidine has gained considerable attention. Dexmedetomidine is a highly selective α_2 -adrenergic receptor agonist with sedative, analgesic, and sympatholytic properties.^[7] It exerts its effects primarily through central actions on the locus coeruleus, producing sedation that closely resembles natural sleep without significant respiratory depression.

Additionally, dexmedetomidine lowers the shivering threshold, making it particularly effective in the prevention and control of perioperative shivering.^[8]

Beyond its anti-shivering properties, dexmedetomidine plays a crucial role in modulating perioperative sedation and hemodynamic stability.^[9] Adequate sedation during spinal anaesthesia is desirable to alleviate patient anxiety, improve comfort, and enhance overall surgical conditions.^[10] Dexmedetomidine provides a unique form of cooperative sedation, allowing patients to remain arousable while maintaining hemodynamic stability. However, its pharmacodynamic profile is associated with dose-dependent effects on heart rate and blood pressure, including bradycardia and hypotension, which necessitates careful monitoring.^[11]

The route of administration of dexmedetomidine significantly influences its clinical effects. Intravenous administration is the most commonly used route, offering rapid onset and titratable sedation.^[12] It has been shown to effectively control post-spinal shivering, provide adequate sedation, and maintain acceptable hemodynamic parameters. Studies have demonstrated that intravenous dexmedetomidine results in faster cessation of shivering, lower recurrence rates, and stable cardiovascular profiles when compared to other agents.^[13] Furthermore, its predictable pharmacokinetics and ease of administration make it a preferred choice in many perioperative settings.^[14]

Intrathecal dexmedetomidine, used with hyperbaric bupivacaine, acts on spinal α_2 receptors to enhance sensory and motor blockade and prolong postoperative analgesia, while also reducing shivering via spinal thermoregulation. It may

provide greater hemodynamic stability due to limited systemic exposure. In contrast, intravenous dexmedetomidine allows better sedation control and titration. Comparative evaluation of both routes is clinically important to assess their effects on shivering, sedation quality, and hemodynamic stability in spinal anaesthesia.^[15]

Hemodynamic stability is a critical determinant of anaesthetic safety, especially in orthopaedic patients who may have associated comorbidities or are at risk of blood loss and fluid shifts. Dexmedetomidine's sympatholytic action leads to a reduction in circulating catecholamines, resulting in decreased heart rate and blood pressure. While these effects are generally mild and well-tolerated, excessive bradycardia or hypotension can occur, particularly with higher doses or rapid administration. Studies evaluating dexmedetomidine in the context of spinal anaesthesia have consistently reported controlled reductions in systolic and diastolic blood pressure and heart rate, with most changes remaining within clinically acceptable limits.^[16]

Another important consideration is the sedative profile of dexmedetomidine. Unlike other sedatives such as benzodiazepines or propofol, dexmedetomidine provides sedation without significant respiratory depression, which is advantageous in patients undergoing regional anaesthesia. The level of sedation achieved is typically dose-dependent and can be tailored according to procedural requirements. Comparative studies have shown that dexmedetomidine produces better sedation scores than agents like tramadol while maintaining patient cooperation and safety.^[17]

Lower limb orthopaedic surgeries under spinal anaesthesia often involve prolonged operative duration and require effective postoperative analgesia. Dexmedetomidine, administered either intrathecally or intravenously, has shown potential to enhance block characteristics, reduce perioperative shivering, and improve patient satisfaction. However, the optimal route that balances efficacy with safety remains unclear. Therefore, a comparative evaluation of intrathecal versus intravenous dexmedetomidine is necessary to assess their effectiveness in controlling shivering, providing adequate sedation, and maintaining hemodynamic stability, thereby optimizing anaesthetic outcomes in such procedures.^[18]

The aim of this study is to compare intrathecal versus intravenous dexmedetomidine as an adjuvant to hyperbaric bupivacaine during spinal anaesthesia for lower limb orthopaedic surgeries. It evaluates perioperative shivering incidence and severity, sedation levels, hemodynamic parameters, and the need for vasoactive interventions, including ephedrine and atropine, to assess overall safety and efficacy between the two routes.

MATERIALS AND METHODS

This prospective, randomized, double blinded comparative clinical study included 90 ASA I and II patients aged 18 to 60 years undergoing elective lower limb orthopaedic surgeries under spinal anaesthesia. Patients were allocated into two groups of 45 each by sealed envelope method. Group A received intravenous dexmedetomidine 0.5 mcg/kg

in 100 mL normal saline before spinal block, whereas Group B received intrathecal dexmedetomidine 5 mcg with 12.5 mg hyperbaric bupivacaine. Heart rate, blood pressure, mean arterial pressure, sedation by Ramsay Sedation Scale, shivering by Crossley and Mahajan score, and ephedrine or atropine requirements were recorded perioperatively and statistically analyzed.

RESULTS

Table 1: Mean age comparison between two groups

	Group A		Group B		p value
	Mean	SD	Mean	SD	
Age	36.98	12.72	36.00	13.87	0.728

The mean age in Group A was 36.98 ± 12.72 years and in Group B was 36.00 ± 13.87 years, with no statistically significant difference between the groups ($p = 0.728$), indicating that both groups were comparable in terms of age distribution.

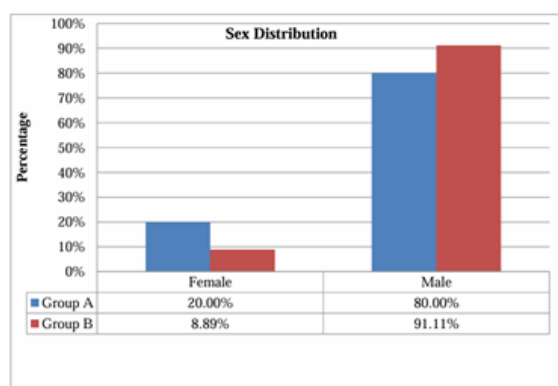


Figure 1: Bar diagram showing sex distribution between two groups

The study population showed male predominance in both groups, with males comprising 80.00% in Group A and 91.11% in Group B, while females accounted for 20.00% and 8.89% respectively. The distribution was comparable between groups,

indicating no significant gender imbalance that could influence study outcomes.

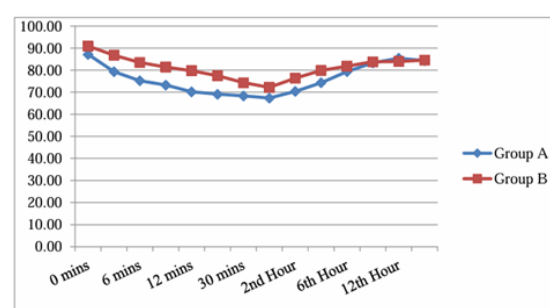


Figure 2: Line diagram means heart rate comparison between two groups at different intervals of time

The mean heart rate in both groups showed a progressive decline following spinal anaesthesia, reaching a nadir during the early intraoperative period, followed by gradual recovery. Group A demonstrated consistently lower heart rate values compared to Group B across most time intervals, indicating a relatively greater bradycardic effect. However, the overall trend remained similar in both groups, suggesting comparable hemodynamic response patterns over time.

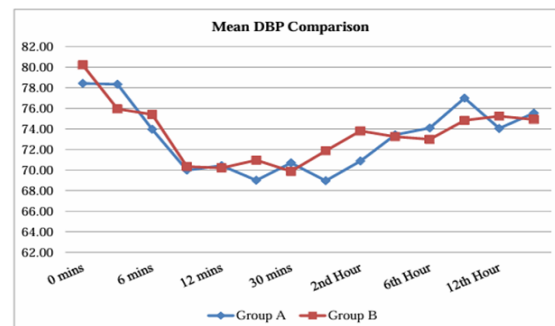
Table 2: Mean SBP comparison between two groups at different intervals

	Group A		Group B		p value
SBP	Mean	SD	Mean	SD	
0 mins	125.96	16.44	129.56	13.77	0.263
3 mins	119.07	14.09	124.82	14.18	0.057
6 mins	115.31	13.46	120.58	15.11	0.084
9 mins	113.42	11.95	117.53	14.89	0.152
12 mins	110.49	12.17	116.89	13.48	0.020*
15 mins	107.47	11.71	116.76	11.53	<0.001*
30 mins	108.58	12.02	115.13	12.52	0.013*
60 mins	107.49	12.07	115.29	13.50	0.005*
2nd hour	112.33	12.17	117.73	12.92	0.044*
4th hour	113.11	11.79	119.76	10.05	0.005*
6th hour	115.44	11.38	120.93	9.52	0.015*
10th hour	120.71	12.31	123.76	8.43	0.175
12th hour	117.04	12.49	123.51	8.78	0.006*
24th hour	117.93	11.54	124.71	8.18	0.002*

The mean systolic blood pressure decreased in both groups following spinal anaesthesia, with a more pronounced reduction observed in Group A compared to Group B. Statistically significant differences were noted from 12 minutes to 6th hour and again at 12th and 24th hour ($p < 0.05$ at multiple intervals), with Group B consistently demonstrating higher SBP values. This indicates better preservation of systolic blood pressure with intrathecal dexmedetomidine. At baseline and early time points, the differences were not statistically significant, suggesting comparable initial hemodynamic status between the groups.

The mean diastolic blood pressure in both groups showed an initial decline following spinal anaesthesia, reaching a nadir during the early intraoperative period, followed by gradual recovery. Group B demonstrated relatively higher DBP values compared to Group A at most time intervals,

indicating better diastolic pressure preservation. However, the overall trends were comparable between groups, suggesting similar hemodynamic response patterns with only modest differences between the two routes.



Graph 3: Line diagram means DBP comparison between two groups at different intervals of time

Table 3: Mean MAP comparison between two groups at different intervals

MAP	Group A		Group B		p value
	Mean	SD	Mean	SD	
0 mins	94.27	12.79	96.71	10.16	0.318
3 mins	91.91	12.39	92.27	10.83	0.885
6 mins	87.73	11.39	90.53	11.50	0.249
9 mins	84.51	10.47	86.09	10.45	0.476
12 mins	83.87	10.68	85.71	9.44	0.388
15 mins	81.80	10.53	86.27	9.26	0.035*
30 mins	83.31	10.51	84.91	9.56	0.452
60 mins	81.78	10.51	86.27	9.70	0.038*
2nd hour	84.69	10.70	88.47	10.84	0.100
4th hour	86.60	10.28	88.71	8.44	0.290
6th hour	87.87	9.97	89.00	7.56	0.545
10th hour	91.58	10.43	91.16	6.57	0.819
12th hour	88.44	9.83	91.31	7.38	0.121
24th hour	89.64	10.03	91.56	7.49	0.309

The mean arterial pressure decreased in both groups following spinal anaesthesia, with a more pronounced reduction observed during the early intraoperative period. Group B consistently demonstrated higher MAP values compared to Group A, with statistically significant differences at 15 minutes ($p = 0.035$) and 60 minutes ($p = 0.038$), indicating better maintenance of perfusion pressure. At other time intervals, the differences were not statistically significant, suggesting overall comparable hemodynamic trends between the groups.

The mean sedation score increased progressively in both groups following administration of dexmedetomidine, reaching peak levels around 30 minutes, followed by a gradual decline over time. Group A demonstrated slightly higher sedation scores compared to Group B during the early intraoperative period, indicating a relatively deeper sedative effect. However, the overall trends were comparable between the two groups, suggesting that

both intrathecal and intravenous dexmedetomidine provide effective and clinically adequate sedation.

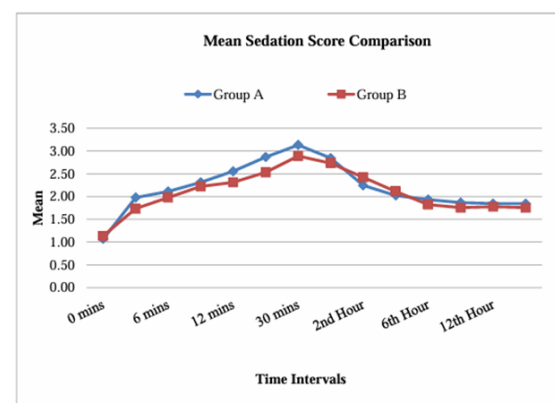


Figure 4: Line diagram means sedation score comparison between two groups at different intervals of time.

Table 4: Mean shivering comparison between two groups at different intervals of time

Shivering	Group A		Group B		p value
	Mean	SD	Mean	SD	
0 mins	0.38	0.61	0.07	0.25	0.002*

3 mins	0.27	0.58	0.20	0.46	0.546
6 mins	0.27	0.50	0.40	0.72	0.309
9 mins	0.22	0.47	0.49	0.87	0.074
12 mins	0.18	0.44	0.58	0.97	0.013*
15 mins	0.16	0.47	0.62	1.01	0.006*
30 mins	0.20	0.59	0.62	0.98	0.015*
60 mins	0.29	0.76	0.78	1.15	0.019*
2nd hour	0.38	0.83	0.50	0.76	0.473
4th hour	0.22	0.60	0.49	0.87	0.094
6th hour	0.11	0.53	0.31	0.76	0.153
10th hour	0.11	0.61	0.09	0.29	0.826
12th hour	0.11	0.75	0.13	0.50	0.869
24th hour	0.04	0.30	0.14	0.63	0.381

The mean shivering scores were significantly lower in Group A compared to Group B at baseline (0 min, $p = 0.002$) and during key intraoperative intervals including 12, 15, 30, and 60 minutes ($p < 0.05$), indicating superior shivering control with intravenous dexmedetomidine. Group B

demonstrated higher shivering scores during the early intraoperative period, reflecting comparatively less effective anti-shivering efficacy. At later time intervals, the differences were not statistically significant, suggesting convergence of effects over time.

Table 5: Total doses of ephedrine intraoperative distribution between two groups

Each Dose: Inj. Ephedrine 6mg IV		Group A		Group B	
		Count	Column N%	Count	Column N%
Total doses of ephedrine intra op	0	44	97.78%	44	97.78%
	1	1	2.22%	1	2.22%

$\chi^2 = 0$, $df = 1$, $p = 1.000$

The requirement of intraoperative ephedrine was comparable between the two groups, with 97.78% of patients in both groups not requiring any dose and only 2.22% requiring a single dose. The difference

was not statistically significant ($p = 1.000$), indicating similar hemodynamic stability and vasopressor requirement in both groups.

Table 6: Total doses of atropine intraoperative distribution between two groups

Each Dose = Inj. ATROPINE 0.6mg IV		Group A		Group B	
		Count	Column N%	Count	Column N%
Total doses of atropine intraoperative	0	45	100.00%	45	100.00%

No patient in either group required atropine intraoperatively, with 100% of patients in both Group A and Group B receiving zero doses. This indicates absence of clinically significant bradycardia requiring intervention and reflects comparable cardiac stability between the two groups.

DISCUSSION

Dexmedetomidine, apart from its analgesic properties, exerts significant effects on sedation, hemodynamic stability, and thermoregulation, making it clinically relevant in spinal anaesthesia. In the present study, sedation levels assessed using the Ramsay Sedation Scale were comparable between intravenous and intrathecal groups, with no statistically significant difference at any time interval. However, a trend toward slightly higher sedation scores was observed in the intravenous group during the early intraoperative period, suggesting a relatively deeper sedative effect. Similar findings were reported by Senapati et al. (2015), whereas Afifi et al. (2016) and Khosravi et al. (2020) demonstrated higher sedation levels with intravenous administration, likely attributable to

greater systemic drug availability and use of infusion-based protocols in those studies.^[19-21]

Hemodynamic parameters in our study revealed that heart rate was consistently lower in the intravenous group at several intraoperative intervals, and systolic blood pressure as well as mean arterial pressure were also significantly reduced in the intravenous group at multiple time points. This reflects a more pronounced systemic sympatholytic effect associated with intravenous dexmedetomidine. These findings are in agreement with Abdallah et al. (2013), who reported significant reductions in heart rate and blood pressure with intravenous dexmedetomidine due to central α_2 -mediated sympatholysis. Importantly, despite these changes, clinically significant adverse events were minimal in our study, with only one patient in each group requiring ephedrine and no requirement of atropine in either group. This indicates that the observed hemodynamic effects were well tolerated and clinically manageable.^[20]

Shivering is a common and undesirable complication of spinal anaesthesia, and dexmedetomidine modulates thermoregulation through central α_2 receptor activity. In the present study, shivering scores were significantly lower in

the intravenous group during key intraoperative intervals (12 to 60 minutes), indicating superior control of perioperative shivering with intravenous dexmedetomidine. These findings are consistent with the study by Usta et al. (2011), which demonstrated a significant reduction in both incidence and severity of shivering with intravenous dexmedetomidine. The hypothalamic modulation of the thermoregulatory threshold is likely responsible for this effect.^[21,22]

However, some studies and meta-analyses have reported and sometimes better anti-shivering efficacy with intrathecal compared to intravenous routes, which may be attributed to differences in dosing regimens, timing of administration, and perioperative environmental factors.^[22] Despite these variations, the present study demonstrates that while both intrathecal and intravenous dexmedetomidine provide effective sedation and acceptable hemodynamic safety, intravenous dexmedetomidine offers superior control of perioperative shivering with manageable cardiovascular effects. Therefore, when shivering prevention and controlled sympatholytic effect are primary clinical considerations, the intravenous route may be preferred, whereas the intrathecal route may offer advantages in terms of block characteristics and analgesic prolongation.

CONCLUSION

Intravenous and intrathecal dexmedetomidine provided comparable perioperative sedation, with no statistically significant difference, although a slight trend toward higher sedation was observed with the intravenous route. Intravenous dexmedetomidine demonstrated superior control of perioperative shivering and produced a greater reduction in heart rate, systolic blood pressure, and mean arterial pressure, reflecting a stronger sympatholytic effect. Despite these changes, hemodynamic alterations were clinically well tolerated, with minimal and comparable ephedrine requirement and no atropine use in either group. Thus, intravenous dexmedetomidine is preferable when effective shivering suppression is desired, whereas intrathecal administration may offer better hemodynamic stability and prolonged neuraxial block.

REFERENCES

- Kamel I, Ahmed MF, Sethi A. Regional anesthesia for orthopedic procedures: What orthopedic surgeons need to know. *World journal of orthopedics*. 2022;13(1):11.
- Amsalu H, Zemedkun A, Regasa T, Adamu Y. Evidence-based guideline on prevention and management of shivering after spinal anesthesia in resource-limited settings. *International journal of general medicine*. 2022;15:6985.
- Sangi S, Kiaei MM, Maroufi SS, Aligholizadeh M, Moradimajid P, Saei A. Shivering management in spinal anesthesia: evaluating the role of ketamine: a narrative review. *Archives of Anesthesia and Critical Care*. 2024.
- Zaza KJ, Hopf HW. Thermoregulation: Normal physiology, anesthetic effects, and perioperative considerations. *Pharmacology and Physiology for Anesthesia*: Elsevier; 2019. p. 300-10.
- Jain A, Gray M, Slisz S, Haymore J, Badjatia N, Kulstad E. Shivering treatments for targeted temperature management: a review. *Journal of Neuroscience Nursing*. 2018;50(2):63-7.
- Lopez MB. Postanaesthetic shivering—from pathophysiology to prevention. *Romanian journal of anaesthesia and intensive care*. 2018;25(1):73.
- Liu X, Li Y, Kang L, Wang Q. Recent advances in the clinical value and potential of dexmedetomidine. *Journal of Inflammation Research*. 2021:7507-27.
- Hoffman J, Hamner C. Effectiveness of dexmedetomidine use in general anesthesia to prevent postoperative shivering: a systematic review. *JBIC Evidence Synthesis*. 2015;13(12):287-313.
- Paranjpe JS. Dexmedetomidine: Expanding role in anesthesia. *Medical Journal of Dr DY Patil Vidyapeeth*. 2013;6(1):5-13.
- Shokri M, Bakhtiari Z, Kargar B, Hajialigol A. The Effect of Intravenous Dexmedetomidine During Surgery in the Prevention of Shivering After General Anesthesia in Patients Undergoing Spinal Surgery: A Randomized Clinical Trial. *Anesthesiology and Pain Medicine*. 2025;15(2):e159077.
- Lotfi AR, Nouribayat L. Comparison of the Effects of Ketamine and Dexmedetomidine on the Incidence of Adverse Events (Nausea and Vomiting, Shivering, Hypotension, and Bradycardia) Following Traumatic Nasal Surgeries. *Journal of Advanced in Medicinal, Pharmaceutical and Biomedical Research*. 2025;1(9):266-74.
- Weerink MA, Struys MM, Hannivoort LN, Barends CR, Absalom AR, Colin P. Clinical pharmacokinetics and pharmacodynamics of dexmedetomidine. *Clinical pharmacokinetics*. 2017;56(8):893-913.
- Venkatraman R, Karthik K, Pushparani A, Mahalakshmi A. A prospective, randomized, double-blinded control study on comparison of tramadol, clonidine and dexmedetomidine for post spinal anesthesia shivering. *Brazilian Journal of Anesthesiology (English Edition)*. 2018;68(1):42-8.
- Wang N, Wang Z, Song X, Wang J. Intravenous dexmedetomidine versus intravenous clonidine for post spinal anesthesia shivering: a meta-analysis of randomized controlled trials. *Scottish Medical Journal*. 2020;65(3):94-102.
- Bi Y-h, Wu J-m, Zhang Y-z, Zhang R-q. Effect of different doses of intrathecal dexmedetomidine as an adjuvant combined with hyperbaric ropivacaine in patients undergoing cesarean section. *Frontiers in Pharmacology*. 2020;11:342.
- Esmat IM, Mohamed MM, Abdelaal WA, El-Hariri HM, Ashoor TM. Postspinal anesthesia shivering in lower abdominal and lower limb surgeries: a randomized controlled comparison between paracetamol and dexamethasone. *BMC anesthesiology*. 2021;21(1):262.
- Mittal G, Gupta K, Katyal S, Kaushal S. Randomised double-blind comparative study of dexmedetomidine and tramadol for post-spinal anaesthesia shivering. *Indian journal of anaesthesia*. 2014;58(3):257-62.
- Mazy A, Ghanem MA, Abd Elatif MSE, Basyoni YE. Spinal anesthesia for lengthy lower limb orthopedic surgeries: dexmedetomidine plus fentanyl versus dexmedetomidine. *Ain-Shams Journal of Anesthesiology*. 2019;11(1).
- Senapati LK, Samanta P. Effect of intravenous versus intrathecal dexmedetomidine on characteristics of hyperbaric bupivacaine spinal anesthesia in lower limb surgery. *Asian J Pharm Clin Res*. 2018;11(7):427-30.
- Afifi M, Mohammed A, Abdullah S, Ellis K. Intrathecal versus intravenous dexmedetomidine in characteristics of bupivacaine spinal block in lower abdominal surgery. *Menoufia Med J*. 2016;29:523-9.
- Khosravi F, Sadeghi N, Jarineshin H. The effect of dexmedetomidine on spinal anesthesia quality and hemodynamic changes in patients undergoing inguinal hernia repair surgery: intravenous versus intrathecal. *European Journal of Clinical Pharmacology*. 2020;76(7):923-8.
- Usta B, Gozdemir M, Demircioglu RI, Muslu B, Sert H, Yaldiz A. Dexmedetomidine for the prevention of shivering during spinal anesthesia. *Clinics*. 2011;66(7):1187-91.