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Analysis of anesthetic quality in elderly patients with femoral shaft fractures applying dexmedetomidine-assisted lumbar plexus block

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Abstract: This research aims to examine the combining dexmedetomidine with lumbar plexus sciatic nerve block in elderly individuals with sustained femoral shaft fractures. 76 elderly patients were randomly divided into observation group (n=38) and control group (n=38). The anesthesia effectiveness was evaluated at multiple time points between the two groups using various factors. In different time points, diastolic blood pressure, systolic blood pressure and heart rate had significant variations in observation group compared to control group, while no difference in the occurrence of adverse reactions. Patients in observation group had a decreased need for analgesics upon awakening and at 12 and 24 hours after surgery; a lower Visual Analog Scale (VAS) score upon awakening and at 6, 12 and 24 hours post-surgery; required lower doses of anesthetics at T2, T3 and T4 time points; lower levels of interleukin-2 (IL-2) and tumor necrosis factor-alpha (TNF-α) at T2 and T3 time points and higher patient satisfaction levels (all $P<0.05$). The combination of dexmedetomidine with lumbar plexus sciatic nerve block proves to be an effective anesthesia technique for elderly patients with femoral shaft fractures and these findings provide support for its broader implementation within clinical practice.

Keywords: Femoral shaft fracture, dexmedetomidine, lumbar plexus sciatic nerve block.

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INTRODUCTION

Femoral shaft fractures, making up approximately 6% of total fractures, are a significant issue in clinical settings (Alimian *et al*., 2021). Usually, due to high-energy impacts and complication risk, they pose a significant threat to both an individual's physical well-being and life quality, necessitating immediate and appropriate medical intervention. Notably, the aging population, particularly in China, has observed an escalating incidence of these fractures, likely attributable to aging-induced decreases in bone density and a corresponding increase in bone fragility (Ao *et al.*, 2022; Aytolign *et al*., 2022). Therefore, improving management techniques is necessary for healthcare providers to face challenge of the global demographic increasing trend of femoral shaft fractures in elderly population.

Managing femoral shaft fractures in the elderly is complicated by comorbidities and need to be addressed to improve outcomes. Current orthopedic practices favor early surgical interventions. However, several elderly patients with conditions such as respiratory and cardiovascular diseases and degenerative organ functions, deteriorating their surgical tolerance and enhancing the risk of postoperative pain, anesthetic complications and mortality rates (Bao *et al*., 2022). In light of these complications, adoption of regional anesthesia, particularly the lumbar plexus-sciatic nerve blockade, has become essential in securing a safe, effective perioperative course for patients undergoing femoral shaft fracture treatment. Lumbar Plexus Block (LPB) is a regional anesthesia technique for pain management in femoral shaft fractures, achieved by injecting local anesthetics around the lumbar plexus nerves. LPB selectively blocks pain signals from the femur to the central nervous system, providing superior pain control compared to systemic analgesia alone, reducing opioid use, enabling early ambulation, improving patient satisfaction and potentially shortening hospital stays. However, LPB must be performed by experienced healthcare professionals aware of potential complications, including nerve injury, infection, and allergic reactions to local anesthetics. Overall, LPB is a valuable technique for managing pain associated with femoral shaft fractures.

In the landscape of lower limb procedures, lumbar plexus-sciatic nerve blockade is favored for its safety, simplicity, and effectiveness in providing postoperative pain relief (Bozorgi *et al*., 2021). Yet, aging subjects exhibit heightened sensitivity to anesthetic and analgesic agents resulting from metabolic slowdown, raising concerns about drug accumulation and potential toxicity. To mitigate these risks, it has become commonplace to supplement intraoperative anesthesia and analgesia with adjuvant drugs like ketamine, antiemetics, opioid receptor antagonists and nonsteroidal anti-inflammatory drugs (Chen *et al.*, 2023).

Dexmedetomidine, a selective α-2 adrenergic receptor agonist has found application as an anesthetic or analgesic adjunctive (Cheng *et al*., 2022), and has shown promise in extending analgesic duration and reducing opioid use. Its successful intrathecal or intravenous administration to

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extend analgesic duration has fueled its widespread use in general or regional anesthesia in surgical settings (Paramasivan *et al*., 2020). Despite these advancements, data concerning perineural dexmedetomidine application in lumbar plexus-sciatic nerve blockades remain scarce, particularly concerning alteration in local anesthetics doses and postoperative analgesic application. There is a lack of data regarding the use of dexmedetomidine in lumbar plexus-sciatic nerve blockades for femoral shaft fractures in the elderly. This study aims to address this gap by examining the implications of single-dose perineural dexmedetomidine combined with lumbar plexus-sciatic nerve blockade on anesthetic and analgesic use and pain management in geriatric patients undergoing surgical intervention for femoral shaft fractures.

MATERIALS AND METHODS

Study design and participants recruitment

This research was conducted as a prospective randomized controlled trial at the Affiliated Hospital of Wuhan Sports University. The selection of this particular facility was based on its ability to provide the necessary resources and patient population required for the study. To guarantee sufficient statistical power for detecting a significant distinction between the observation and control groups, an adequate sample size was determined beforehand by conducting a pre-study power calculation. By calculating the sample size beforehand, we aimed to enhance the validity of our findings by ensuring sufficient statistical power. Patients were assigned randomly into either the observation or control group using a computer-generated randomization method, which helped minimize any potential bias in participant assignment and ensured an equal chance of being assigned to either group.

Inclusion criteria of participants: (1) Diagnosis based on the disease diagnostic criteria outlined in "Practical Orthopedics" (Donatiello *et al*., 2022); (2) Patients and their relatives signed an informed consent form and were aware of the relevant details of the experiment; (3) Basic ability to listen, speak, read, and write; (4) Complete medical records, meeting the indications for surgery; (5) No patients with hematological or neurological diseases. The exclusion criteria included: (1) Presence of contraindications for surgery or anesthesia; (2) Preoperative use of opioid or psychotropic drugs; (3) Age less than 60 years; (4) Individuals experiencing an infection in the area where the puncture was made; (5) Patients with senile dementia or psychiatric illnesses who cannot cooperate; (6) Patients who withdrew from the study midway.

Intervening methods

The described anesthetic procedures were aligned with current best practices and guidelines for the surgical intervention under investigation. Control group: General anesthesia was performed by administering 0.03-0.05 mg/kg midazolam (Jiangsu Enhua Pharmaceutical Co., Ltd., National Drug Approval No. H19990027, 1 ml: 5 mg) + 2-4μg/kg fentanyl (Yichang Renfu Pharmaceutical Co., Ltd., National Drug Approval No. H20003688, 10 ml: 0.5 mg) intravenously. After anesthesia induction, 1-2 mg/kg propofol (Sichuan Guorui Pharmaceutical Co., Ltd., National Drug Approval No. H20040079, 10 ml: 0.1 g) was administered by intravenous infusion, and the patient's bispectrality index (BIS) was monitored until it decreased to 60-80.

Observation Group: In addition to the above procedures, the experimental group received dexmedetomidine combined with lumbar plexus sciatic nerve block. A nerve stimulator was connected, and the stimulation frequency was set at 1 Hz with an intensity of 1 mA and a pulse duration of 0.1 ms. The patient's position was adjusted to the lateral decubitus position with the body flexed. Two perpendicular parallel lines were drawn from the level of the fourth lumbar spinous process, and the needle was inserted at the intersection of these lines at the 1/3 point. The muscle perfusion was observed during the procedure, and any convulsive phenomena were noted. The current intensity was gradually adjusted to 0.25-0.35 mA. Dexmedetomidine (Sichuan Guorui Pharmaceutical Co., Ltd., National Drug Approval No. H20143195, 1 mL: 100 μg) at a dose of 1 μg/kg, mixed with 20 ml of distilled water was selected and slowly injected around the nerves of the patient. The trochanter major of the femur and the center of the line connecting the posterior superior iliac spine was used as the reference line for needle insertion, aiming towards the line connecting the sacral foramen. The movement of the calf muscle was carefully checked, and another injection of the mixture containing dexmedetomidine and distilled water was administered. Both groups received a continuous infusion of propofol at a rate of 100-200 μg/kg/min, while waiting for the BIS index to reach 40-60. The BIS index was measured every 5 minutes during the operation, and the propofol infusion rate was adjusted according to the results. If the BIS index was below 40, the propofol dose was reduced by 20%; if the BIS index exceeded 60, the propofol dose was increased by 20%. During the surgery, if the patient experienced hypertension or tachycardia, an additional dose of 1μg/kg fentanyl could be administered. If the desired effect was not achieved within 10 minutes, the dose could be repeated.

Observational indexes

(1) The measurements of diastolic blood pressure, systolic blood pressure, and heart rate were taken for each group at T1 (one hour into the surgery), T2 (two hours into the surgery), and T3 (three hours into the surgery).

(2) The administration of analgesic medications upon awakening, 12 hours after the surgical procedure, and 24 hours after the surgical procedure was documented for each group. Furthermore, the utilization of anesthetic

medications during T1 (induction phase), T2 (1 hour into surgery), T3 (2 hours into surgery), T4 (3 hours into surgery), as well as the overall usage during the surgical procedure and anesthesia phase were also recorded.
(3) Pain intensity was evaluated using a Visual Analog Scale (VAS) at the moment of waking up, 6 hours after surgery, 12 hours after surgery, and 24 hours after surgery for each group. The scale had a range from 0 to 10, with higher scores indicating greater pain severity (Edinoff *et al*., 2021).
(4) The level of satisfaction with anesthesia was assessed post-surgery using a rating scale ranging from 0 to 100. A score between 75 and 100 indicated a high level of satisfaction, while a score between 55 and 74 denoted a moderate level of satisfaction. Any score below 55 suggested dissatisfaction. The determination of the overall satisfaction level involved combining the scores for both "high" and "moderate" levels of satisfaction.
(5) The concentrations of interleukin-2 (IL-2) and tumor necrosis factor-alpha (TNF-α) were assessed at T1 (prior to surgery), T2 (12 hours after surgery), and T3 (24 hours after surgery) in each respective group. The determination of IL-2 and TNF-α concentrations were performed using Human IL-2 ELISA Kit (Cusabio, Wuhan, China) and Human TNF-α ELISA Kit (Cusabio, Wuhan, China), respectively, according to the manufacturer's instructions. The absorbance was measured at a wavelength of 450 nm (Infinite M2000, Tecan Trading AG, Switzerland).
(6) The occurrences of negative responses following the surgical procedures were documented for each cohort.

Ethical approval

This study was approved by the ethics committee of Affiliated Hospital of Wuhan Sports University (672HREC20250317-L11). Signed written informed consents were obtained from the patients and/or guardians.

STATISTICAL ANALYSIS

The data obtained in this research were examined utilizing the Statistical Package for Social Science (SPSS) 20.0 application (IBM, Armonk, NY, USA). For continuous variables represented by mean ± standard deviation (s), t-tests were employed. For categorical variables represented by percentages, $\chi 2$ tests were used. A significance level of $P<0.05$ was deemed to suggest a statistically significant disparity in the data.

RESULTS

General information

From January 2021 through June 2022, our hospital admitted a total of 76 senior patients suffering from femoral shaft fractures. Using a method of randomizing the list, the participants were evenly divided into two groups consisting of 38 individuals each.

The group under observation consisted of 21 males and 17 females, aged between 63 and 84 years, with an average age of 72.45±7.51 years. Among these, 12 patients were rated as ASA grade I, and the remaining 26 patients were classified as ASA grade II. The body mass index (BMI) of the observation group ranged from 21 to 28 kg/m^2, with an average BMI of 24.55±3.17 kg/m^2.

On the contrary, the comparison group consisted of 23 male individuals and 15 female individuals, aged between 61 and 85 years, with an average age of 72.63±7.27 years. Within this group, 11 patients were classified as ASA grade I, while 27 were marked as ASA grade II. The BMI for this group fluctuated from 21 to 27 kg/m^2, with a mean value of 24.13 ± 2.86 kg/m^2.

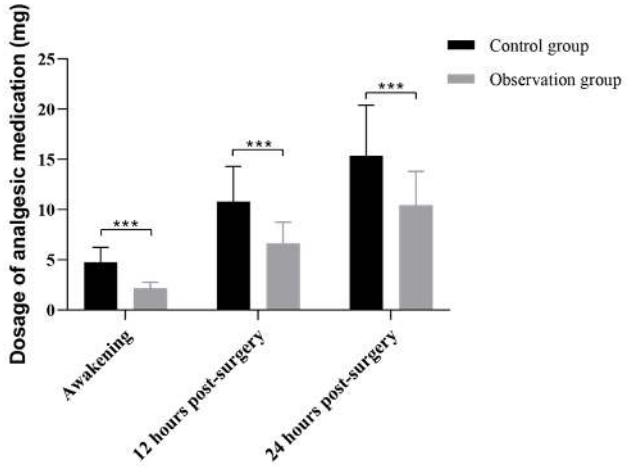

Fig. 1: Dosage comparison of analgesic medication at different time points. ***: $P<0.001$.

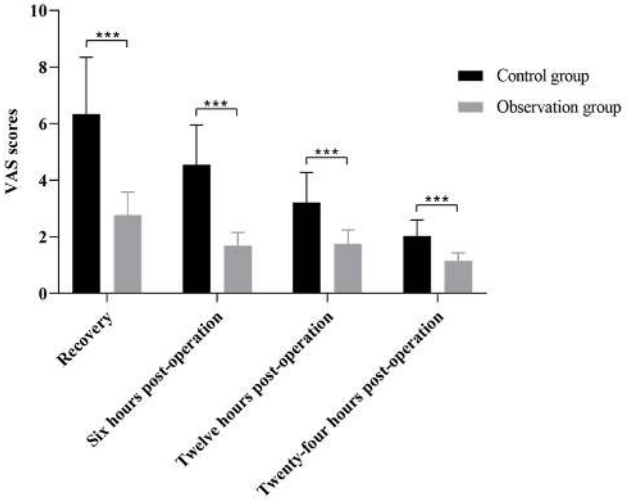

Fig. 2: Comparison of VAS scores at different time points. ***: $P<0.001$.

A comparison of the baseline characteristics between the two groups did not yield any statistically significant findings ($P>0.05$). The basic characteristics of the patients were well-matched between the two groups, which enhances the reliability of the study. These similarities in age, gender, ASA grade and BMI allow for a meaningful comparison of the outcomes.

Table 1: Changes in heart rate and blood pressure in each group

Group	Diastolic pressure (mmHg)		
	T1	T2	T3
Observation group (n=38)	80.13±8.58	74.69±7.56	72.15±5.33
Control group (n=38)	66.67±6.21	68.93±6.12	69.53±5.08
t	7.834	3.650	2.193
P	<0.001	<0.001	0.031
Group	Systolic pressure (mmHg)		
	T1	T2	T3
Observation group (n=38)	116.04±8.69	113.02±8.36	108.32±8.37
Control group (n=38)	120.72±8.18	117.91±8.71	112.71±8.16
t	2.417	2.497	2.315
P	0.018	0.015	0.023
Group	Heart rate (beats/min)		
	T1	T2	T3
Observation group (n=38)	93.04±9.14	86.27±8.91	82.83±6.56
Control group (n=38)	84.57±8.63	77.39±7.45	79.84±6.12
t	16.617	4.713	2.054
P	<0.001	<0.001	0.043

Table 2: Dosage comparison of anesthetic medication at different time points (μg)

Group	T1	T2	T3	T4	Total intraoperative dose	Total anesthesia stage dose
Observation group (n=38)	126.37±12.24	45.12±4.29	36.77±3.04	31.29±3.85	88.46±10.25	207.94±20.32
Control group (n=38)	129.51±12.80	68.48±6.31	57.21±5.76	42.46±4.19	134.17±14.68	241.01±24.96
t	1.093	18.872	19.346	12.101	15.738	6.334
P	0.278	<0.001	<0.001	<0.001	<0.001	<0.001

Table 3: Comparison of satisfaction levels among groups (%)

Group	Highly satisfied	Moderately satisfied	Dissatisfied	Satisfaction level
Observation group (n=38)	21	15	2	36 (94.74)
Control group (n=38)	14	15	9	29 (76.32)
χ^2	-	-	-	5.208
P	-	-	-	0.023

Table 4: Changes in inflammatory markers among groups

Group	IL-2 (μg/ml)		
	T1	T2	T3
Observation group (n=38)	23.28±6.02	26.04±7.53	20.31±7.88
Control group (n=38)	22.91±5.87	30.76±7.11	24.97±7.60
t	0.271	2.810	2.624
P	0.787	0.006	0.011
Group	TNF-α (pg/ml)		
	T1	T2	T3
Observation group (n=38)	18.03±2.55	22.01±2.89	16.35±1.48
Control group (n=38)	18.41±2.16	26.78±3.60	20.14±2.37
t	0.701	6.369	8.361
P	0.486	<0.001	<0.001

Table 5: Comparison of adverse reactions among groups (%)

Group	Dry mouth	Nausea/vomiting	Headache	Urinary retention	Incidence rate
Observation group (n=38)	1	2	2	1	6 (15.79)
Control group (n=38)	1	1	1	1	4 (10.53)
χ^2	-	-	-	-	0.461
P	-	-	-	-	0.497

Changes in heart rate and blood pressure in each group

Table 1 presents the statistically significant differences (P<0.05) observed in the diastolic blood pressure (80.13±8.58, 74.69±7.56, 72.15±5.33), systolic blood pressure (116.04±8.69, 113.02±8.36, 108.32±8.37) and heart rate (93.04±9.14, 86.27±8.91, 82.83±6.56) between the observation group and control group at T1, T2, and T3 periods of measurement.

The control group exhibited different values for diastolic and systolic blood pressure (66.67±6.21, 68.93±6.12, 69.53±5.08, 120.72±8.18, 117.91±8.71, 112.71±8.16) and heart rate (84.57±8.63, 77.39±7.45, 79.84±6.12).

The statistical analysis reveals a significant disparity (P<0.05) in systolic and diastolic blood pressure, as well as heart rate, between the observation group and the control group. These findings imply that the treatment administered to the observation group may have influenced cardiovascular parameters compared to the control group. Further examination is warranted to explore the clinical implications and potential factors contributing to these variations.

Comparison of analgesic dose at different time points in each group

Fig. 1 displays the notable variances (P<0.05) in analgesic medication dosage between the observation group and control group upon awakening, 12 hours after surgery, and 24 hours after surgery.. The observation group demonstrated lower dosages (2.15±0.61, 6.63±2.11, 10.42±3.37) compared to the control group (4.76±1.48, 10.81±3.50, 15.36±5.02). The observation group exhibited a statistically significant decrease in the dosage of analgesic medication required at various time points compared to the control group (P<0.05). This finding suggests that the treatment administered to the observation group may have contributed to improved pain management or reduced reliance on analgesics. It is crucial to explore potential factors contributing to these disparities and their implications for patient comfort and recovery.

Comparison of VAS scores at different time points in each group

Fig. 2 demonstrates a significant decrease (P<0.05) in VAS scores noted among the observation group when compared to the control group during awakening, 6 hours after surgery, 12 hours after surgery, and 24 hours after surgery.. The observation group exhibited decreased VAS scores (2.76±0.81, 1.68±0.46, 1.75±0.48, 1.14±0.28) in contrast to the control group (6.34±2.01, 4.55±1.41, 3.21±1.06, 2.02±0.57). The VAS scores in the observation group exhibited significant decreases compared to those in the control group at various time intervals (P<0.05). These findings imply that the treatment administered to the observation group may have contributed to enhanced pain management and diminished perception of pain when compared to the control group. It is imperative to elucidate the clinical importance of these results and their implications for postoperative care.

Comparison of anesthetic doses at different time points in each group

At T1, the dosage of anesthesia medication did not show any statistically significant difference (P>0.05) between the groups (126.37±12.24 vs. 129.51±12.80). However, at T2, T3 and T4, the observation group demonstrated lower dosages (45.12±4.29, 36.77±3.04, 31.29±3.85) compared to the control group (68.48±6.31, 57.21±5.76, 42.46±4.19). Furthermore, the total dosage during surgery (88.46±10.25) and the total dosage during the anesthesia phase (207.94±20.32) were lower in the observation group than in the control group (134.17±14.68, 241.01±24.96) (P<0.05. (table 2). The observation group received lower doses of anesthesia medication at different time points, including during surgery and the anesthesia phase (P<0.05). This finding indicates that the treatment provided to the observation group may have resulted in a more efficient and precise administration of anesthesia. It is important to discuss the potential benefits of lower anesthetic doses, such as faster recovery and reduced risk of adverse events.

Comparison of satisfaction among each group

Table 3 displays the levels of satisfaction observed in both the observation group and the control group. Within the observation group, high satisfaction was expressed by 21 participants, moderate satisfaction by 15 participants, and dissatisfaction by 2 participants. Conversely, within the control group, high satisfaction was expressed by 14 participants, moderate satisfaction by 15 participants, and dissatisfaction by 9 participants. The rate of satisfaction in the observation group (94.74%) exhibited a significant increase compared to that in the control group (76.32%) (P<0.05). Notably, there was a statistically significant difference favoring higher patient satisfaction levels in the observation group when compared to those in the control group (P<0.05), suggesting that treatment received may have contributed to this disparity between groups.. It is

important to explore the factors contributing to this difference and their implications for patient-centered care and treatment outcomes

Changes in inflammatory markers among groups

At T1, there was no statistically significant difference (P>0.05) in the levels of IL-2 (23.28±6.02 vs. 22.91±5.87) and TNF-α (18.03±2.55 vs. 18.41±2.16) between the groups. However, at T2 and T3, the observation group demonstrated lower levels of the following indicators compared to the control group: IL-2 (26.04±7.53 vs. 30.76±7.11), TNF-α (20.31±7.88 vs. 24.97±7.60), IL-6 (22.01±2.89 vs. 26.78±3.60), and CRP (16.35±1.48 vs. 20.14±2.37) (P<0.05). Refer to table 4 for more details. The observation group demonstrated lower levels of inflammatory markers, including IL-2, TNF-α, IL-6, and CRP, compared to the control group at different time points (P<0.05). These changes in inflammatory markers indicate that the treatment provided to the observation group may have resulted in a reduced inflammatory response to surgery compared to the control group. Further discussion is needed to explain the significance of these findings and their potential impact on postoperative recovery and complications.

Comparison of adverse reactions among groups

In the observation group, a single instance of xerostomia, two instances of emesis and nausea, two instances of cephalalgia, and one instance of urinary retention were observed. Similarly, in the control group, there was an occurrence of dry mouth, emesis and nausea each, as well as cephalalgia and urinary retention. The occurrence of adverse reactions in the observation group (15.79%) did not exhibit a significant statistical difference compared to the control group (10.53%) (P>0.05, table 5) The observation group and the control group showed no statistically significant difference in the occurrence of unfavorable responses (P>0.05). This suggests that the treatment given to the observation group did not significantly increase the probability of adverse events compared to the control group It is important to discuss the clinical relevance of these findings and whether any specific adverse reactions were more prevalent in either group.

DISCUSSION

The statistically significant global population of individuals aged over 60 is experiencing growing incidence rates for fractures, notably proximal femoral fractures, with the approximate annual worldwide total cases of 600,000 (Goel & Desai, 2021). In response, clinical practices resort to surgical interventions like open reduction and internal fixation, which facilitate normal callus formation and expedited fracture healing (Hong *et al.*, 2021). However, since the majority of geriatric patients have pre-existing conditions like coronary heart disease and hypertension, coupled with their deteriorated physiological functions, a appropriate anesthesia selection is required for these procedures to avoid hemodynamic fluctuations that can lead to delayed postoperative recovery (Ibrahim *et al*., 2019; Jin *et al.*, 2021). In the present study, we found the combination of dexmedetomidine with lumbar plexus sciatic nerve block proves to be an effective anesthesia technique for elderly patients with femoral shaft fractures, and these findings are significant in the context of anesthesia and pain management for femoral shaft fractures, particularly in elderly patients.

Over recent years, advancements in anesthesia technology suggest general anesthesia may fall short of meeting contemporary clinical requirements, especially in terms of reducing anesthetic dosage and managing postoperative pain, thereby impacting patient recovery outcomes (Luan *et al*., 2023). Local administration of anesthetic agents to peripheral nerves suffers from limitations owing to total body absorption, thereby significantly diluting the drugs' local effects. Propofol, an intravenous anesthetic agent frequently used in anesthesia induction and maintenance during surgery, provides distinct advantages, but can also induce hypotension (Yilmaz *et al*., 2024). As an effective adjunct or sedative for anesthesia, α-2 adrenergic receptor agonists have shown promise (Lashgarinia *et al*., 2014). Among them, notably, dexmedetomidine, which has shown potential to reduce sevoflurane usage by over 70% during anesthesia with minimal changes to arterial blood gas and blood pressure (Methods, 2023). Furthermore, MUNOZ-LEYVA F *et al*. showed the utility of dexmedetomidine in reducing propofol demand (Munoz-Leyva *et al*., 2022). Although dexmedetomidine's benefits as an adjuvant to propofol have been demonstrated, research on its effects when locally administered via peripheral nerves during a lumbar plexus sciatic nerve blockade, particularly on the propofol dosage required to maintain sufficient anesthesia depth, remains limited.

Deepening clinical research suggests the efficacy of combining dexmedetomidine with lumbar plexus sciatic nerve blockade. It effectively compensates for the shortcomings of general anesthesia, reduces anesthetic and analgesic drug dosage, promotes rapid pain alleviation, enhances postoperative comfort, and expedites recovery. The current investigation unveiled notable statistical differences (P<0.05) in diastolic blood pressure, systolic blood pressure, and heart rate between the experimental group and control group during T1, T2, and T3. Furthermore, the group under observation exhibited a decreased need for analgesic medication in comparison to the control group upon regaining consciousness, at the 12-hour mark and after 24 hours post-surgery (P<0.05). In addition, the group under observation showed decreased scores on the visual analog scale (VAS) compared to the control group upon waking up and also at 6 hours, 12 hours and 24 hours after

surgery (P<0.05). While there was no statistically significant disparity in anesthetic dosage at T1 across the groups (P>0.05), it was noted that the observation group required lower quantities compared to the control group at T2, T3, and T4 In addition, the group under observation demonstrated a reduced overall amount of anesthesia administered during both surgery and the anesthesia stage in comparison to the control group (P<0.05). The observation group achieved a satisfaction rate of 94.74%, which was significantly higher than the control group's rate of 76.32% (P<0.05). There were no significant variations observed in IL-2 and TNF-α levels among the groups at T1 (P>0.05). However, the observation group exhibited significantly lower levels at T2 and T3 compared to the control group (P<0.05). The occurrence rate of adverse reactions in the observation group was 15.79%, showing no significant difference compared to the control group with a rate of 10.53% (P>0.05). Therefore, the observation group effectively navigated anesthetic and analgesic drug dosages, maintained stable vital signs, mitigated inflammatory reactions and experienced fewer adverse reactions, which enhanced patient satisfaction.

Introduction pain after orthopedic surgeries represents a special concern, which may be meaningful for clinicians to improve health outcomes as well as instruct postoperative care in patients with fractures. In fact, several mechanisms, including inflammation, injury receptor activation, direct nerve damage and neuropathic mechanisms, are involved in acute postoperative pain, creating targets for analgesic development (Stabile *et al.*, 2022; Tang *et al*., 2022). Though the exact physiological, pathological, and pharmacological mechanisms of local dexmedetomidine application to peripheral nerves remain elusive, studies by THOMSON R *et al*., have shown that alpha-2 adrenoceptor agonists such as clonidine might play a role in inflammation-mediated and centrally-mediated analgesia and peripheral nerve regulation via vasoconstriction (Thomson *et al*., 2021). Moreover, studies have revealed that clonidine and dexmedetomidine affect changes in intracellular and extracellular potassium concentrations, thereby regulating cell membrane potentials to produce postoperative analgesic effects. As such, postoperative dexmedetomidine effects cannot be reversed by alpha-2 adrenoceptor antagonists (Wei *et al*., 2023; Wu *et al.*, 2022). This study also suggests that when peripheral nerve infiltration is used in patients subjected to lumbar plexus sciatic nerve blockade, nerve blockade duration extends without needing additional local anesthetics. Similarly in the present study, elderly femoral shaft fractures patients with dexmedetomidine-assisted lumbar plexus block have a significantly lower dose of anesthetic medication both intraoperative and at anesthesia stage than controls. A randomized, controlled trial showed that whole-course application of dexmedetomidine as an adjuvant to spinal-epidural anesthesia could effectively extend the analgesic duration of ropivacaine following elective cesarean surgery (Wu *et al.*, 2024). Dexmedetomidine could also improve the anesthesia quality and decreased the neuronal hyperactivities and the overactive behaviors when combined with esketamine in mice (Chu *et al.*, 2021). Additionally, research by XIAO R *et al*. suggests that alpha-2 adrenoceptor agonists can reduce postoperative pain and opioid analgesic demand, thereby reducing associated adverse reaction incidences (Xiao *et al.*, 2022). Also, we observed that dexmedetomidine significantly reduces pain at different time points and enhances patient satisfaction when peripheral nerve infiltration is applied during a lumbar plexus sciatic nerve blockade. In conclusion, incorporating dexmedetomidine into regional anesthesia protocols may lead to improved perioperative outcomes, including enhanced pain control, reduced opioid use, and faster recovery.

As mentioned before, dexmedetomidine, categorized as a sedative or adjuvant for anesthesia, can reduce the dosage of other anesthetic and analgesic drugs whilst mildly impacting blood pressure and arterial blood gas measurements (Sheikh & Baig, 2023). According to our results, patients in the observation group have significantly lower systolic pressure and higher diastolic pressure compared to controls, which acknowledges that dexmedetomidine can induce hypotension and affect hemodynamic stability. However, research has shown that dexmedetomidine's effects on blood pressure are mild and manageable with appropriate monitoring and dose adjustments (Elsabeeny *et al*., 2023). Meanwhile, the findings of the study indicated that there was no noteworthy disparity in the occurrence rates of adverse reactions between the groups under observation and control. On the other hand, we explored the change in concentrations of inflammatory factors, and found that at T2 and T3, both IL-2 and TNF-α were significantly lower in observation group than those in control group, indicating that the combination of dexmedetomidine with lumbar plexus and sciatic nerve blocks may attenuate inflammation after surgery. Surgery-associated tissue damage stimulates systemic inflammatory cascades to induce a surge in the release of cytokines and stress hormones, and leucocyte migration to the site of injury, and the excessive inflammatory responses are thought to cause a series of complications (Wang *et al*., 2019). Study has confirmed i that dexmedetomidine was beneficial for the promotion of the reduction of serum IL-6, IL-8 and TNF-α levels in patients with thyroid cancer, thereby reducing the inflammatory injury in the central nervous system, indicating the anti-inflammatory potentials of dexmedetomidine (Nagamine *et al*., 2015). Undelying mechanisms may involve inhibition of the pro-inflammatory cytokine production, and central sympatholytic effects, including the stimulation of cholinergic anti-inflammatory pathway and the

antinociceptive action involving interactions between pain and immune factors (Venn *et al.*, 2001; Ma *et al.*, 2020; Qiao *et al.*, 2009).

The study findings have significant clinical relevance, particularly in the context of improving perioperative outcomes for elderly patients undergoing surgery for femoral shaft fractures. Reduced anesthetic and analgesic requirements, enhanced pain control, and improved patient satisfaction are meaningful clinical improvements that result from the use of dexmedetomidine in combination with lumbar plexus and sciatic nerve blocks. The research has recognized certain limitations, including a limited number of participants and a specific group of patients. Further investigations could fill these gaps by examining the prolonged impacts of dexmedetomidine, its application in diverse patient groups, or in conjunction with alternative pain management approaches. Future research should explore optimal dosing regimens for dexmedetomidine, investigate potential adverse effects associated with its use and assess its efficacy in different surgical contexts.

CONCLUSION

The study findings support the potential benefits of combining dexmedetomidine with lumbar plexus and sciatic nerve blocks in clinical practice. Incorporating dexmedetomidine into regional anesthesia protocols may lead to improved perioperative outcomes for elderly patients undergoing surgery for femoral shaft fractures. The study's results suggest that dexmedetomidine can significantly reduce pain, reduce anesthetic and analgesic requirements, and enhance patient satisfaction.

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