Am J Transl Res 2024;16(10):5283-5295
www.ajtr.org /ISSN:1943-8141/AJTR0158150

Original Article

Efficacy of dexmedetomidine epidural anesthesia combined with nano-silver polyurethane dressing in gynecological surgery and its influence on hemodynamics, inflammatory response and postoperative recovery

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Received May 29, 2024; Accepted August 9, 2024; Epub October 15, 2024; Published October 30, 2024

Abstract: Objective: To evaluate the effectiveness of dexmedetomidine epidural anesthesia combined with nano-silver polyurethane dressing in gynecological surgery. Methods: This retrospective study analyzed data of 80 patients who underwent epidural anesthesia at Jinan Maternal and Child Health Care Hospital from January 2018 to May 2022. The patients treated with propofol and routine postoperative wound treatment were assigned into a control group, while the patients treated with dexmedetomidine and nano-silver polyurethane dressing were classified into an observation group. The baseline data, anesthesia effect, intraoperative basic indexes, hemodynamics indexes, postoperative recovery indexes, recovery quality, inflammatory response and adverse reactions were compared between the two groups. Results: The observation group demonstrated a significantly higher rate of excellent and good outcomes (97.5%) compared to the control group (85.0%) ($P < 0.05$). The anesthesia recovery time of the observation group was notably longer than that of the control group ($P < 0.05$). The Ramsay score and levels of mean arterial pressure in the observation group were higher than those in the control group, while the heart rate level was significantly lower than that in the control group (all $P < 0.05$). The wound healing time, dressing change times and visual analogue scale (VAS) score in the observation group were obviously lower than those in the control group (all $P < 0.05$). The Pittsburgh sleep quality index score in the observation group was lower than that in the control group, and the 40-items quality of recovery score in the observation group was higher than that in the control group (both $P < 0.05$). The serum IL-6, CRP and TNF-α levels in the observation group were lower than that in the control group (all $P < 0.05$). The total incidence of adverse reactions in the observation group (7.5%) was significantly lower than that in the control group (25.0%) ($P < 0.05$). Conclusion: In gynecological surgeries utilizing epidural anesthesia, dexmedetomidine minimally impacts hemodynamics and provides good anesthesia and sedation with a low incidence of adverse drug reactions. Nano-silver polyurethane dressing accelerates wound healing, reduces the dressing changes, alleviates the inflammatory response, and reduces the occurrence of wound infection, thereby enhancing postoperative recovery quality.

Keywords: Epidural anesthesia, dexmedetomidine, gynecological surgery, nanometer silver polyurethane dressing, wound healing

Introduction

Anesthetics and anesthetic techniques are crucial in surgical practices. Opting for the minimal effective dosage of anesthetic can expedite patient awakening while maintaining stable vital signs and maximizing sedative effects during the procedure [1, 2]. Epidural anesthesia is commonly used in gynecological surgery, which has the advantages of ease of use, ability to avoid respiratory interventions, reduced stress reactions, and the ability to maintain consciousness and protective reflex while improving coronary artery perfusion in patients [3]. At the same time, epidural anesthesia has good controllability of anesthesia time, effective postoperative analgesia, and few pulmonary complications [4]. Long surgery duration, coupled with nervousness, anxiety and other adverse emotions, patients undergoing gynecological surgery may experience a strong stress reaction and a variety of risks during surgical treatment. The management of intraoperative anesthesia profoundly influences both the surgical outcome and postoperative recovery. Therefore, it is critical to employ appropriate sedative techniques to maintain vital signs and ensure a positive prognosis in patients undergoing gynecological surgery with epidural anesthesia [5].

In contemporary anesthetic practice, the use of combination medications is recognized for enhancing anesthetic efficacy while minimizing adverse drug reactions. Traditional sedatives and analgesics have become less effective [6]. Recent trends have favored the use of benzodiazepines; for instance, Midazolam has been widely used in preoperative medication, induction and maintenance of general anesthesia and sedation in intensive care settings [7, 8]. Dexmedetomidine is a highly effective drug for α2-adrenoceptor activation with strong selectivity [9]. Dexmedetomidine limits the transmission of pain signals primarily by acting on α2-adrenoceptor in interneurons and the dorsal horn of the spinal cord, inhibiting the release of sensory neurotransmitters such as substance P, reducing the stress release of cortisol. Dexmedetomidine can also inhibit the release of presynaptic neurotransmitters by binding to presynaptic C nerve fibers, and by interacting with postsynaptic receptors in the spinal dorsal horn, it effectively blocks sodium influx, achieving sensory and motor blockade [10]. When used in epidural anesthesia, dexmedetomidine acts as a hypnotic by targeting the locus ceruleus, inducing and maintaining natural non-rapid eye movement sleep [11]. Therefore, dexmedetomidine is highly effective as a sedative in epidural anesthesia, exerting minimal impact on respiratory function, maintains hemodynamic stability, and not affecting postoperative recovery of gynecological patients.

Poor wound healing after operation is a significant complication, leading to pain deterioration, prolonged treatment time, and increased workload for medical staff [12]. In gynecological surgery, poor incision healing is often observed in patients with thicker abdominal wall fat and lower resistance; some of these patients may also suffer from complications such as anemia or malnutrition, which further impair tissue healing capabilities [13]. The use of wet wound healing dressing can help maintain a moist wound environment and appropriate temperature under closed or semi-closed conditions, thereby facilitating wound recovery [14]. In clinical settings, medical polyurethane is a frequently utilized wound protection film. This material is flexible, adheres well, and is biodegradable, effectively reducing wound exposure to external contaminants while maintaining the wound's integrity and dryness. It is predominantly used for large-area wound closures [15]. Nano-silver, a mainstream composite antibacterial material at present, can kill pathogenic bacteria, reduce inflammation and pain, and accelerate wound healing by continuously releasing nano-silver ions. By combining nano-silver with polyurethane materials, the overall antibacterial capacity is enhanced, offering improved sealing properties [16]. Additionally, the introduction of nanotechnology can effectively improve the blood compatibility of polyurethane materials and reduce the risk of thrombosis [17]. The nano-silver polyurethane dressings, leveraging these benefits, are potent in moisturizing and antibacterial properties, and are clinically used in the treatment of burns and surgical wounds.

To date, the reports on dexmedetomidine epidural anesthesia combined with nano-silver polyurethane dressing for gynecologic surgery are scarcely reported. Therefore, to address this gap, this study investigated the effect of dexmedetomidine epidural anesthesia combined with nano-silver polyurethane dressing in gynecological surgery, particularly focusing on hemodynamics, inflammatory response and postoperative recovery.

Materials and methods

Research subjects

A retrospective analysis was conducted on the data of 80 patients who underwent epidural anesthesia at Jinan Maternal and Child Health Care Hospital from January 2018 to May 2022. The surgeries included radical cervicectomy, adnexal mass resection, myomectomy, subtotal hysterectomy and total hysterectomy.

Inclusion criteria: patients with American Society of Anesthesiologists (ASA) grade I-II [18]; patients who received epidural anesthesia and were fully conscious and cooperative throughout the treatment. Exclusion criteria: patients with significant cardiovascular or pulmonary disease, other major organ impairments; patients with coagulation dysfunction, hepatic or renal insufficiency; patients with a history of prolonged use of sedatives, analgesics, and psychiatric medications.

According to their intervention protocols, the patients were split into an observation group (n = 40) and a control group (n = 40). The control group received propofol for epidural anesthesia, and postoperative wound care was managed with conventional treatments. The observation group was administered dexmedetomidine for anesthesia, and wounds were treated with nano-silver polyurethane dressings.

Methods

Upon entering the surgical room, all patients were immediately connected to monitoring devices to track their mean arterial pressure (MAP) and heart rate (HR). Prior to anesthesia, each patient received a 500 ml intravenous infusion of compound sodium lactate. Each patient received a 500 ml intravenous infusion of compound sodium lactate. Epidural puncture was performed in the L2-3 space, and an epidural catheter was placed toward the proximal end of the head. The anesthesia level was verified by acupuncture test. 2% lidocaine (3-5 ml) was injected three times to observe the state of the patient and maintain the anesthesia block level above T_8 level. Once the anesthesia block was stabilized, the patient was changed to supine position, and anesthetics were injected intravenously. Patients in the observation group were given dexmedetomidine (Jiangsu Hengrui Pharmaceutical Co., Ltd., approval number: H20090248) at a dose of 0.5 μg/kg. After continuous infusion of 5 min, the dose was adjusted to 0.4 μg/(kg·h) for continuous infusion until abdominal closure. Patients in the control group were given propofol (Guorui Pharmaceutical Co., Ltd., approval number: H20030115) at 60 μg/(kg·min) intravenously. Throughout the surgery, the bispectral index (BIS) of electroencephalogram was maintained between 70-80 [19]. After operation, the epidural catheter was removed, and the patients were sent back to the ward after the anesthesia level dropped below T_{10}.

Following surgery, the control group received treatment with normal saline and iodophor. When necessary, sutures were removed, necrotic tissue excised, and the wound was cleaned, drained, and covered with iodoform gauze. Dressing was changed based on incision evaluations. The observation group was treated with nano-silver wet dressing. After routine cleaning of the wound, a piece of polyurethane material infused with nano-silver was cut to match the size of the wound. A medical semipermeable film was then used to secure the dressing, ensuring full contact with the wound surface. The antibacterial mechanism of the nano-silver polyurethane is illustrated in **Figure 1**, and its microscopic characteristics are depicted in **Figure 2**. The dressing was maintained to ensure optimal wound temperature and humidity, and changes were made according to specific wound conditions.

Data collection

Baseline data: The baseline data of the two groups were collected, including age, weight, course of disease and disease type.

Anesthesia effect: Evaluation criteria: ① Excellent. The patient has no pain during the operation, exhibits good muscle relaxation, remains composed and quiet throughout, without any episodes of choking, coughing or physical activity, which indicates an excellent anesthesia effect. ② Good. The patient experiences mild traction pain during the operation, proper muscle relaxation, and may show slightly painful expressions. Occasional agitation may occur but does not interfere with the surgical process, indicating a good anesthesia effect. ③ Poor. The patient experiences significant traction pain, extremely painful expression, frequent choking cough, and extensive limb movement during the operation, disrupting the operation and requiring pharmacological intervention to complete, indicating a poor anesthesia effect. Excellent and good rate of anesthesia = (excellent + good) cases/total cases × 100%.

Surgery-related indices: The surgery-related indicators were collected and compared bet-

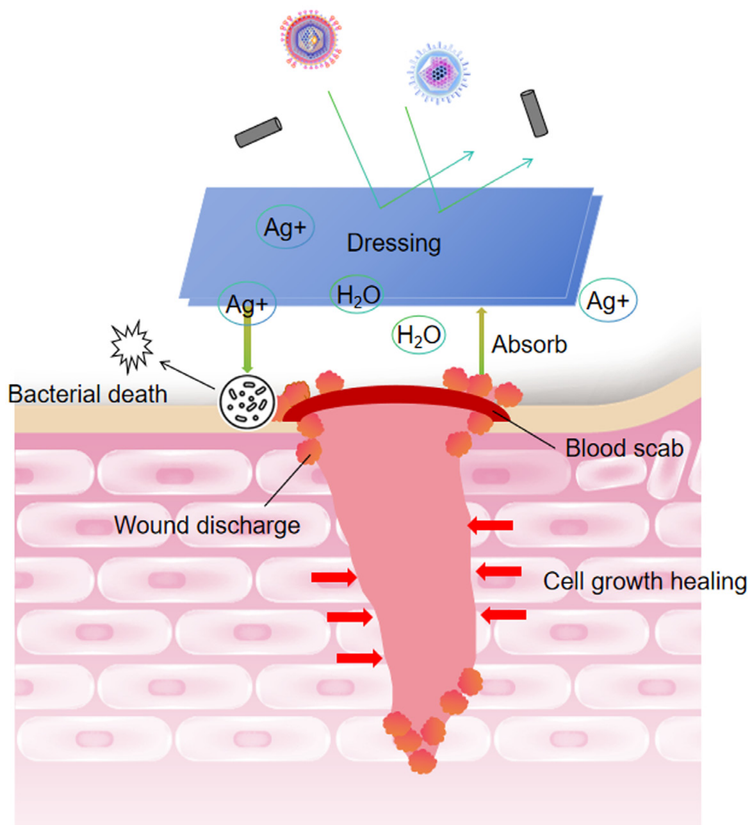

Figure 1. Schematic diagram of the anti-bacterial mechanism of nano-silver polyurethane dressing.

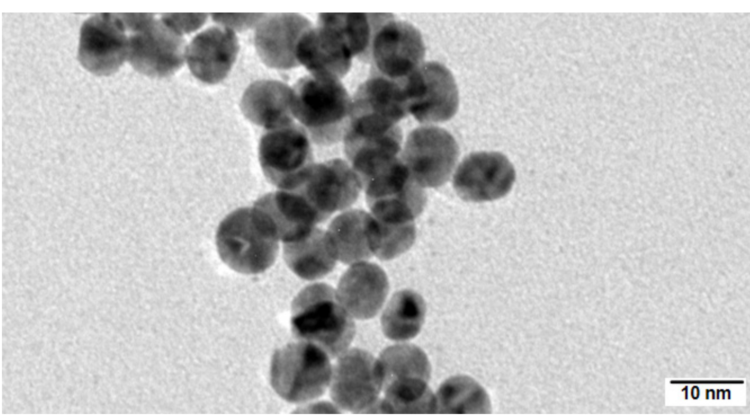

Figure 2. Microscopic observation of nano-silver polyurethane.

ween the two groups, including operation time, perioperative bleeding, respiratory recovery time and anesthesia recovery time.

Hemodynamics indexes: Hemodynamic indices, including mean arterial pressure (MAP) and heart rate (HR), were recorded at several key points: before administration (T_0), 15 minutes after administration (T_1), at the start of the operation (T_2), and at the end of the operation (T_3). The sedation effect of the two groups was evaluated by Ramsay sedation score system. The higher the Ramsay score, the more obvious the sedation effect.

Postoperative recovery indexes: The postoperative recovery indexes for both groups were collected, including wound healing time, number of dressing changes, and pain intensity as measured by Visual Analogue Scale (VAS) after operation. The higher the VAS score, the stronger the pain was. Patients were followed up postoperatively, with regular outpatient visits to assess wound healing and monitor recovery progress.

Recovery quality: The Pittsburgh sleep quality index (PSQI) was used to evaluate the sleep quality of patients in both groups. The higher the PSQI score, the worse the sleep quality. Additionally, the 40-item quality of recovery score (QoR-40) was used to evaluate the quality of recovery of patients in both groups, with higher score reflecting better postoperative recovery.

Inflammatory response: After the operation, 5 ml of peripheral venous blood was collected from each patient and allowed to stand before centrifugation. The separated serum was collected and frozen at -70°C. Serum levels of inflammatory factors such as interleukin-6 (IL-6), C-reactive protein (CRP) and tumor necrosis factor-α (TNF-α) were measured by enzyme-linked immuno-sorbent assay (article number: BH-E100491, BH-S63478,

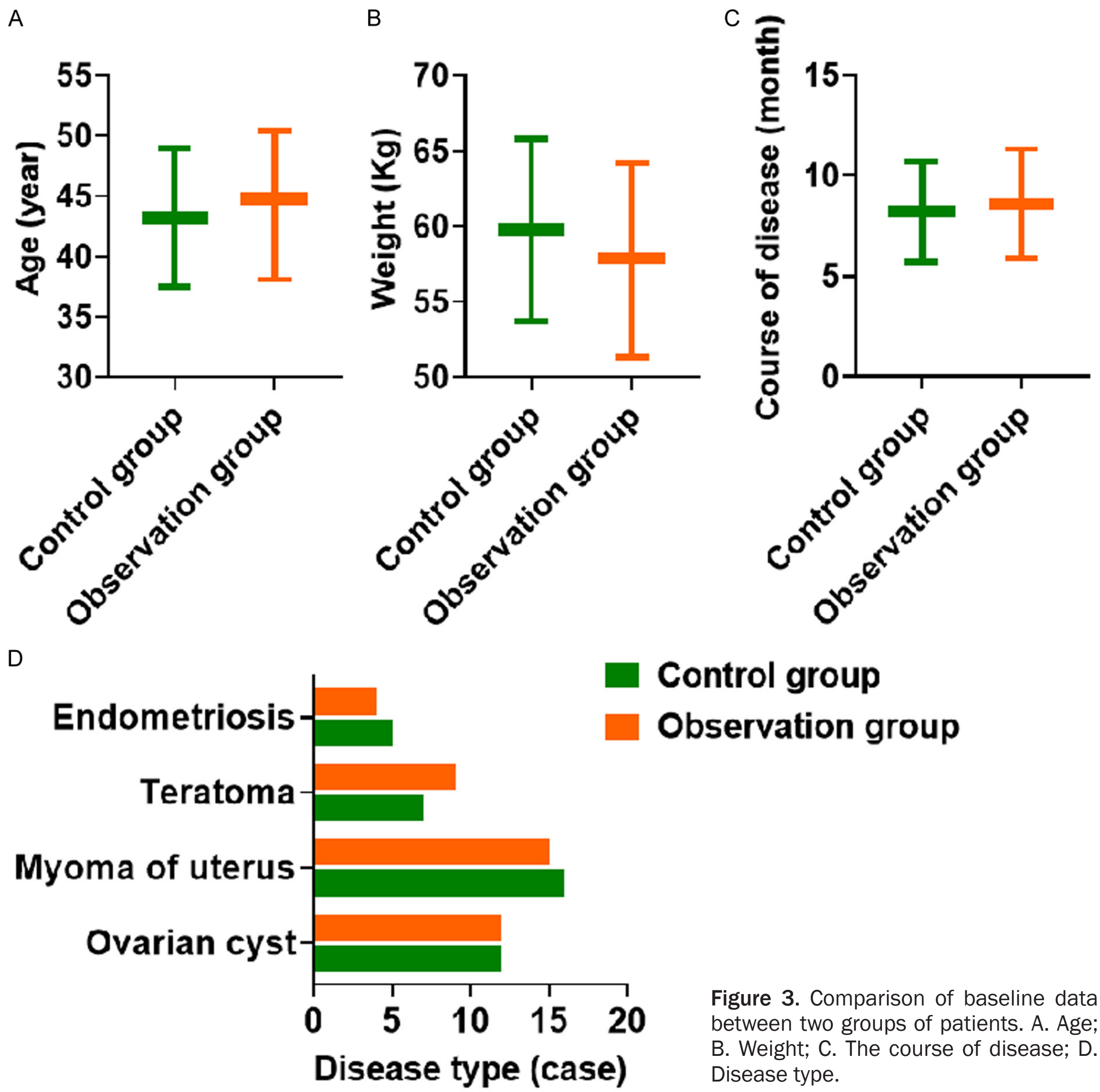

Figure 3. Comparison of baseline data between two groups of patients. A. Age; B. Weight; C. The course of disease; D. Disease type.

BH-E98585). ELISA test kits were purchased from Shanghai Bohu Biotechnology Co., Ltd. All procedures were conducted strictly according to the manufacturer's instructions.

Adverse reactions: Adverse reactions collected from both groups included respiratory depression, bradycardia, hypotension, wound infection and restlessness.

Statistical method

SPSS 21.0 statistical software was used to process the data. Measurement data in accordance with a normal distribution were expressed by mean ± SD and compared using t-test. Repeated measurement ANOVA was used for comparison among different time points within the group, and LSD-t test was used for further pairwise comparison. Categorical data were expressed as percentage (%) and compared using χ^2 test. $P < 0.05$ was considered statistically significant.

Results

Comparison of baseline data between the two groups

There was no significant difference in baseline data such as age, weight, course of disease and disease type between the two groups (all $P > 0.05$), as shown in **Figure 3**.

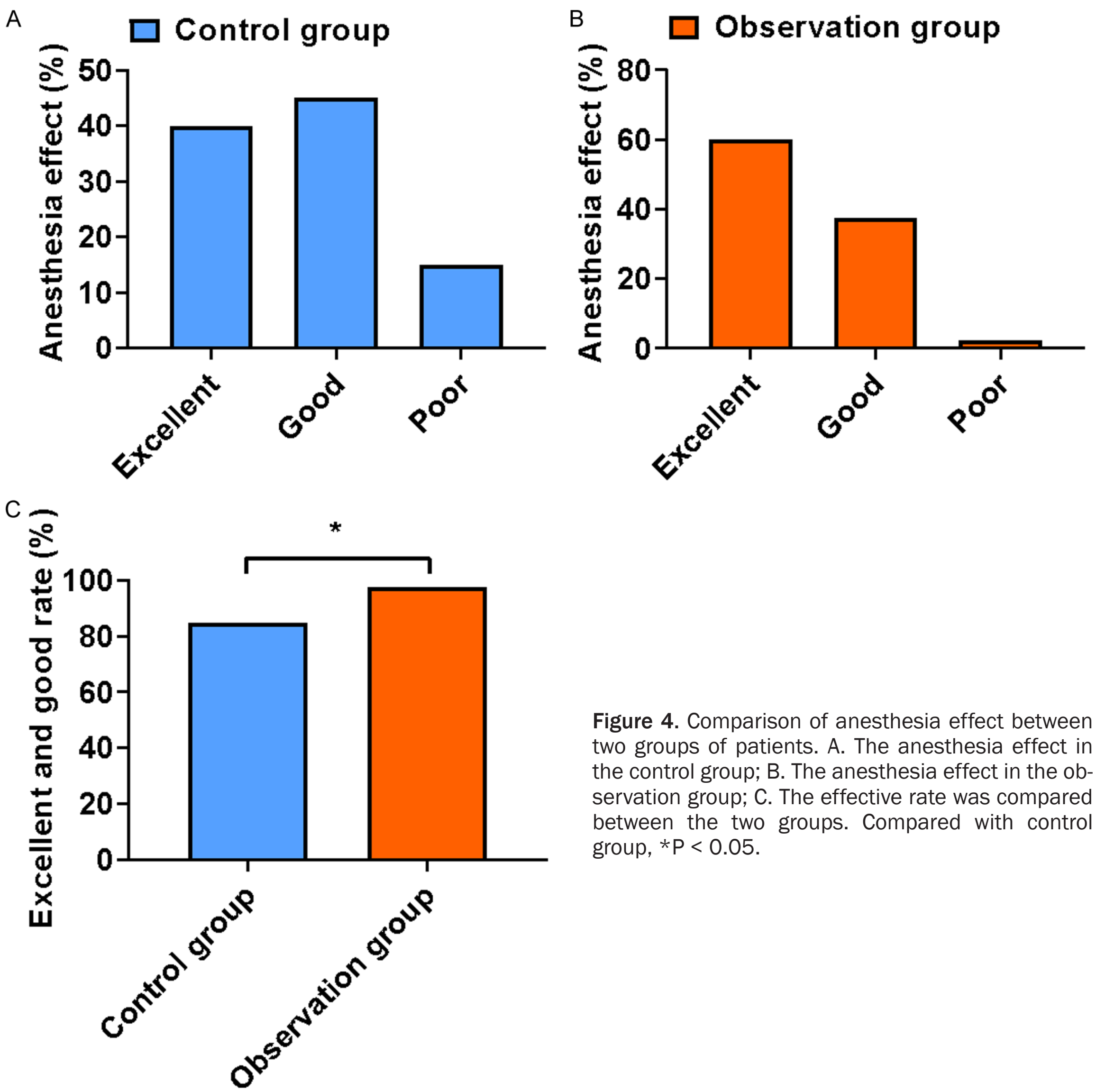

Figure 4. Comparison of anesthesia effect between two groups of patients. A. The anesthesia effect in the control group; B. The anesthesia effect in the observation group; C. The effective rate was compared between the two groups. Compared with control group, *P < 0.05.

Comparison of anesthesia effect between the two groups

The excellent and good rate of the observation group (97.5%) was significantly higher than that of the control group (85.0%) ($P < 0.05$), as shown in **Figure 4**.

Comparison of intraoperative indices between the two groups

There was no significant difference in operation time, perioperative bleeding volume and respiratory recovery time between the two groups (all $P > 0.05$). However, the anesthesia recovery time of the observation group was longer than that of the control group ($P < 0.05$), as shown in **Figure 5**.

Comparison of Ramsay score and hemodynamic indices between the two groups at various intervals

As shown in **Figure 6**, there was no significant difference in Ramsay score at T_0 between the two groups ($P > 0.05$), but the Ramsay score at T_1, T_2 and T_3 in the observation group was significantly higher than those in the control group (all $P < 0.05$). There was no significant difference in the levels of MAP and HR between the two groups at T_0 ($P > 0.05$), but the levels of MAP at T_1, T_2 and T_3 in the observation group

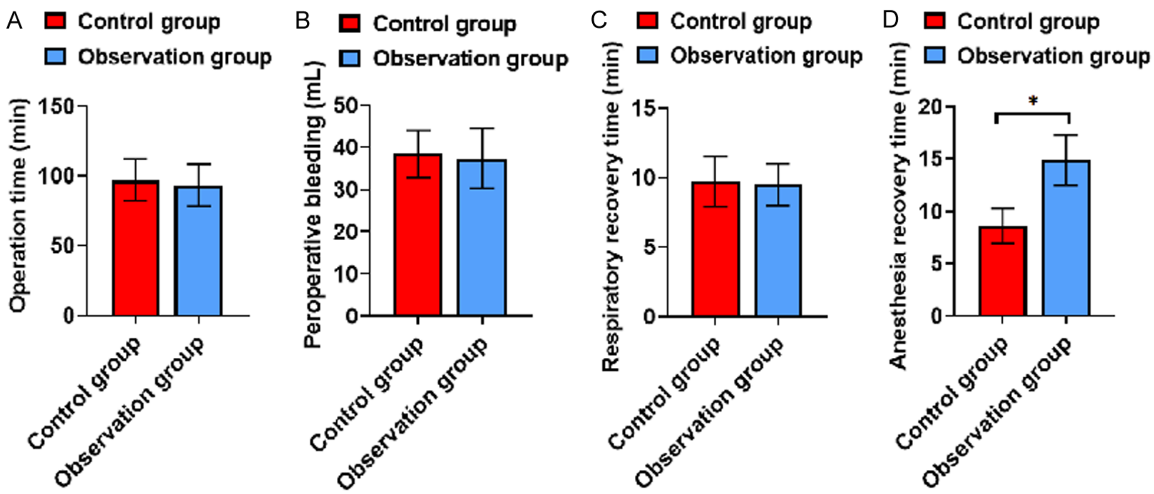

Figure 5. Comparison of intraoperative indices between the two groups of patients. A. Operation time; B. Perioperative bleeding; C. Respiratory recovery time; D. Anesthesia recovery time. Compared with control group, *P < 0.05.

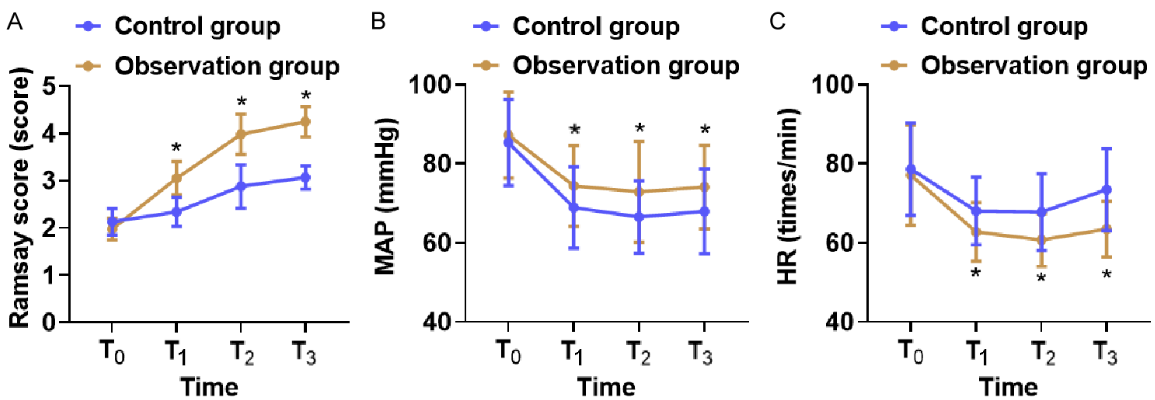

Figure 6. Comparison of Ramsay score and hemodynamic indices between the two groups at different intervals. A. Ramsay score; B. MAP; C. HR. Compared with control group, *P < 0.05. MAP: mean arterial pressure; HR: heart rate.

were significantly higher than those in the control group, while the levels of HR were notably lower than those in the control group (all P < 0.05).

Comparison of postoperative recovery indices between the two groups

The wound healing time, dressing change frequencies and VAS score in the observation group were notably less than those in the control group (all P < 0.05), as shown in **Figure 7**.

Comparison of recovery quality between the two groups

As shown in **Figure 8**, the PSQI score in the observation group was lower than that in the control group, while the QoR-40 score in the observation group was higher than that in the control group (all P < 0.05).

Comparison of inflammatory factors between the two groups

The serum IL-6, CRP and TNF-α levels in the observation group were all significantly lower than those in the control group (all P < 0.05), see **Figure 9**.

Comparison of adverse reactions between the two groups

The adverse reactions in the control group included respiratory depression, bradycardia, hypotension, restlessness and wound infec-

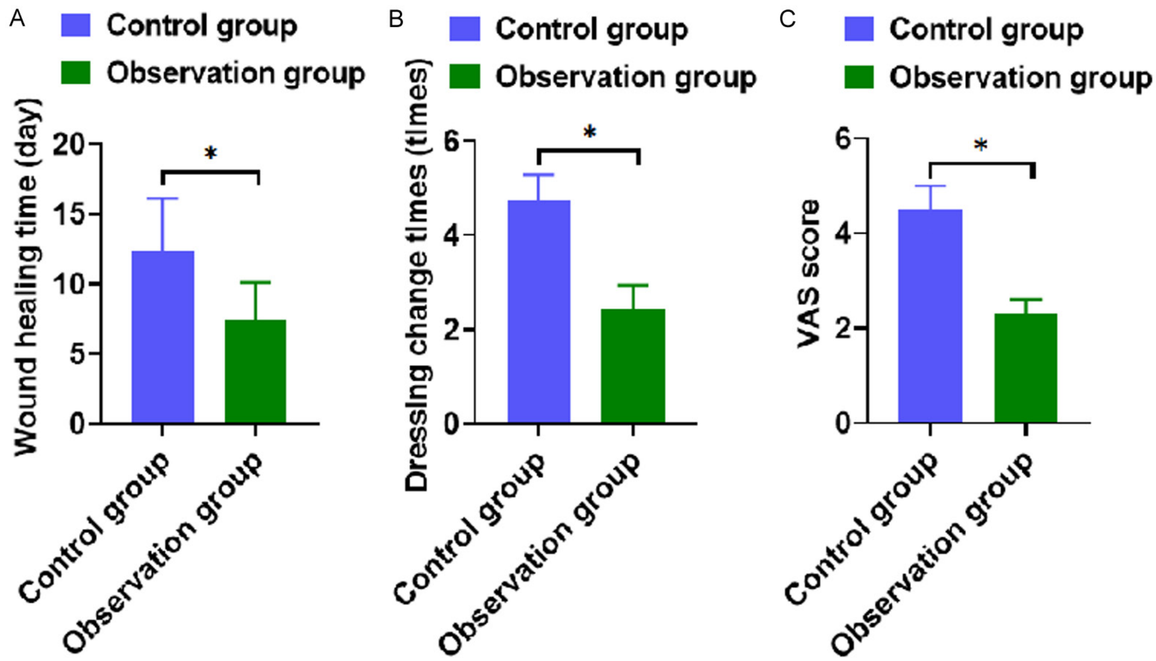

Figure 7. Comparison of postoperative recovery indices between the two groups. A. Wound healing time; B. Dressing change times; C. VAS score. Compared with control group, *P < 0.05. VAS: visual analogue scale.

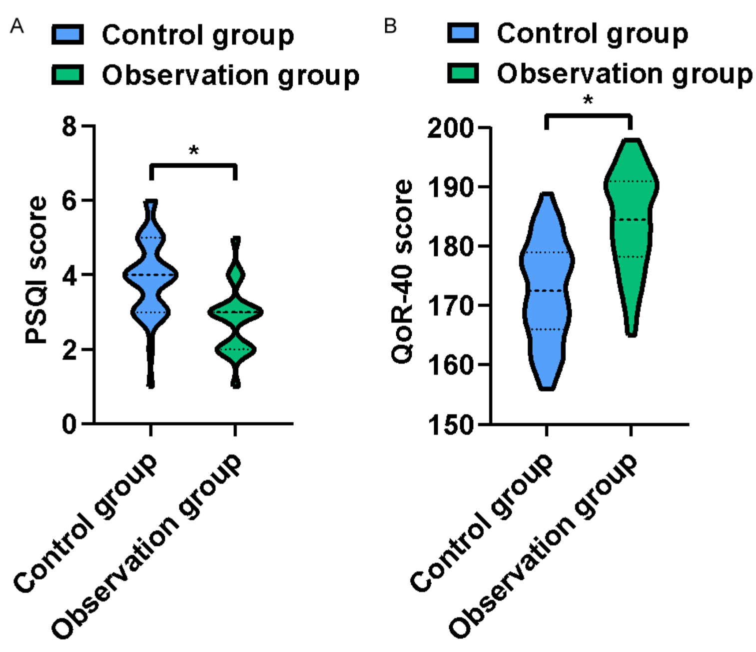

Figure 8. Comparison of recovery quality between the two groups. A. PSQI score; B. QoR-40 score. Compared with control group, *P < 0.05. PSQI: Pittsburgh sleep quality index; QoR-40: 40-items quality of recovery score.

tion, while those in the observation group included bradycardia and restlessness. The total incidence of adverse reactions in the observation group (7.5%) was significantly lower than that in the control group (25.0%) (P < 0.05), as shown in **Figure 10**.

Discussion

Gynecological illness is common in clinical settings, negatively affecting patients' quality of life and their physical and mental health [20]. Surgery is still a primary choice for a majority of gynecological disorders, and a successful procedure is heavily reliant on effective anesthesia and anesthetic medications. Epidural anesthesia is often favored for gynecological surgeries due to its rapid onset, extended duration, high safety profile, and low incidence of adverse effects [21]. Although patients typically remain conscious during procedures performed under epidural anesthesia, they may experience heightened psychological stress prior to anesthesia. This stress can lead to tension, anxiety, and fear, triggering a stress response that can

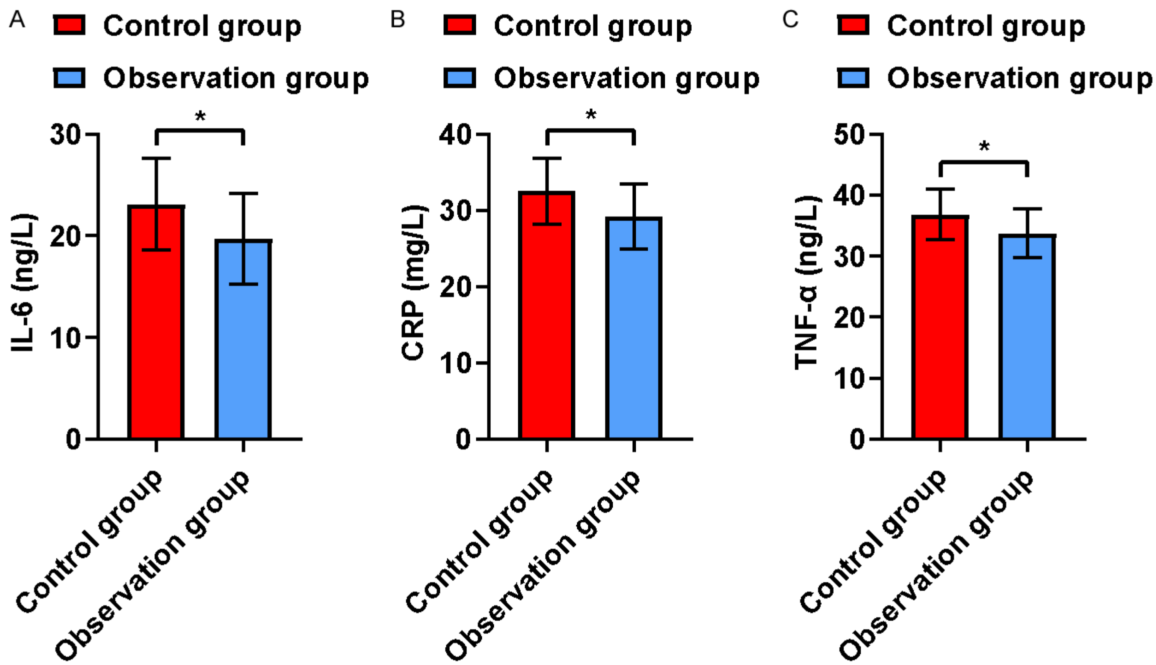

Figure 9. Comparison of inflammatory factors between the two groups. A. IL-6; B. CRP; C. TNF-α. Compared with control group, *P < 0.05. IL-6: interleukin-6; CRP: C-reactive protein; TNF-α: tumor necrosis factor-α.

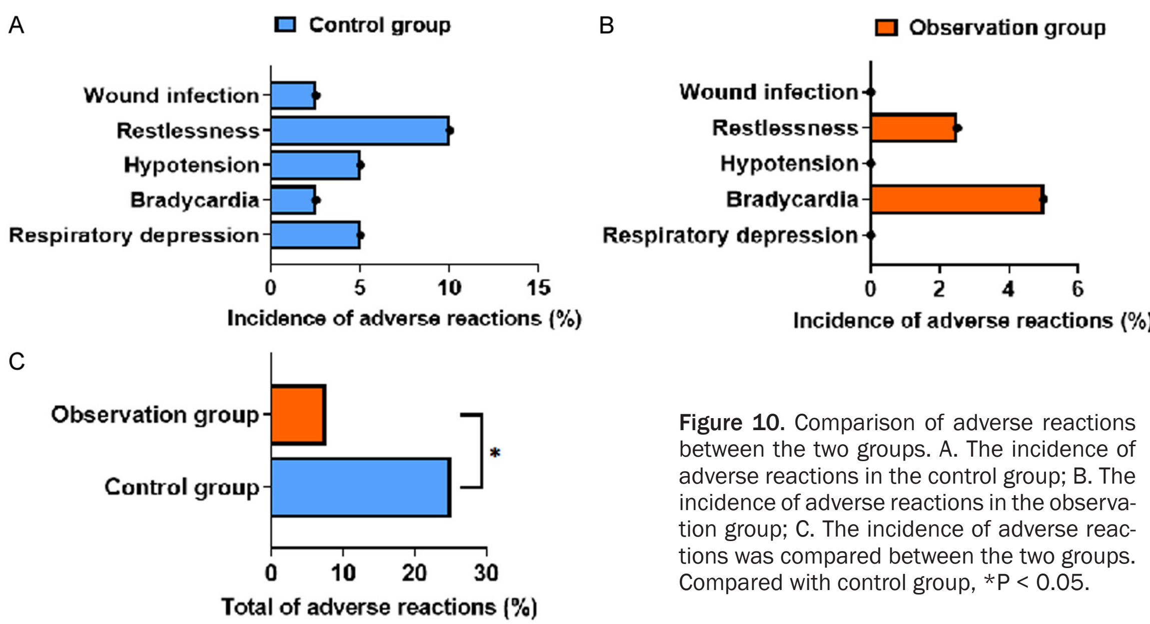

Figure 10. Comparison of adverse reactions between the two groups. A. The incidence of adverse reactions in the control group; B. The incidence of adverse reactions in the observation group; C. The incidence of adverse reactions was compared between the two groups. Compared with control group, *P < 0.05.

result in abnormal vital signs and compromise the therapeutic outcomes of the surgery [22]. Therefore, selecting appropriate anesthetics for epidural anesthesia is crucial for patients undergoing gynecological surgery.

Administration of auxiliary sedatives during the operation can alleviate discomfort and reduce negative emotions once they regain consciousness. This is beneficial for both the procedure and the patients' post-operative rehabilitation [5]. Commonly used sedatives include propofol and dexmedetomidine [23]. Propofol is known for its rapid onset and swift recovery times, making it a popular choice in traditional surgical anesthesia [24]. This study found no significant difference between dexmedetomidine and propofol in terms of operation time, perioperative bleeding and respiratory recovery time; however, patients administered dexmedetomidine experienced a delayed recovery from anesthesia. The pharmacokinetics of dexmedetomidine, characterized by its relatively slow onset and emergence from anesthesia, are linked to its distribution half-life of about 5 minutes and a clearance half-life of approximately 2 hours. Although less controllable than propofol, dexmedetomidine's longer elimination half-life compensates for propofol's limited analgesic effects [25, 26].

The mechanism of dexmedetomidine may involve controlling norepinephrine release, reducing blood catecholamine levels, inhibiting cation hyperpolarization, improving the levels of inflammatory factors, and blocking nociceptive conduction. Yang et al. demonstrated that dexmedetomidine binds to peripheral and central α2 adrenergic receptors, decreasing the production of pain-related mediators, thereby blocking the transmission of pain signals, enhancing analgesia during cesarean section [27]. Li et al. explored the effects of different doses of dexmedetomidine on hysteroscopic submucosal myomectomy, finding that 0.5 μg/kg dexmedetomidine provided effective analgesia and maintained hemodynamic stability [28]. In this study, the hemodynamic study showed that the MAP of the observation group was higher than that of the control group, and the HR was lower than that of the control group. During anesthesia, maintaining MAP within the normal range helped reduce the incidence of intraoperative hypotension, which is also supported by our findings. Additionally, this study discovered that the excellent and good rate of the observation group was higher than that of the control group, the Ramsay score of the observation group at each period was higher than that of the control group. According to clinical research, propofol has a relatively short anesthesia time, requires continuous administration. It can also easily trigger a stress response in patients, which might have an impact on the stability of hemodynamic indicators [29]. According to findings from other research, the blood flow changes induced by dexmedetomidine closely resemble those seen in human natural sleep [30]. When it comes to the maintenance of epidural anesthesia, dexmedetomidine can sustain a better anesthetic effect than propofol since it has a better analgesic impact and causes no injection discomfort or respiratory inhibition. Thus, this study demonstrates that, when used in epidural anesthesia for gynecological surgery, dexmedetomidine has a good anesthetic and sedative effect while having less of an impact on blood flow stability. Zeng et al. reported that dexmedetomidine activates the endogenous sleep pathway by acting on α2 receptors in the intracranial nucleus accumbens, thus restoring normal circadian rhythms and alleviating insomnia [31]. Bosch et al. summarized that dexmedetomidine reduces anxiety, improves mood, and facilitates the regulation of sleep through neuroprotective and anti-inflammatory effects [32]. This study found that dexmedetomidine reduced postoperative pain, negative emotions such as irritability and anxiety by inhibiting neuronal discharges and cytokine release, which improved physical comfort, sleep quality, and overall postoperative recovery. Additionally, the total incidence of adverse reactions in the observation group was significantly lower than that in the control group, underscoring the safety of dexmedetomidine. These findings are consistent with those reported by Zhang et al. [33].

Metzger et al. confirmed through clinical studies that wet wound healing dressings, which maintain moisture, are the most effective approach for wound management [34]. These dressings help control oxygen tension within the wound, promote capillary formation, and stimulate the release of various growth factors. In the course of a wound healing process, these growth factors can help to keep the skin's surface at a constant temperature, facilitate tissue growth, prevent re-mechanical harm to newly formed granulation tissue, safeguard the nerve endings of the wound, and lessen excruciating pain [35]. The wet healing dressing creates a local environment around the wound that is hypoxic, slightly acidic and humid, which can effectively prevent the invasion of bacteria, improve local immunity and enhance the ability of sterilization [36]. Clinically, these dressings are more comfortable than traditional ones, reducing the frequency of dressing changes, and alleviate pain incision and post-application pain aggravation [37]. Due to the small size and strong penetration capabilities of nano-silver particles, they can effectively enter into the bacterial body and bind with bacterial DNA, disrupting cell structure, reducing bacteria population, showing excellent antibacterial activity, and collectively promoting the healing of wounds [38]. Some scholars believe that polyurethane dressings containing nano-silver can enhance their antimicrobial effect through the sustained release of silver ions upon contact with wounds, reducing pathogenic microorganisms in wounds and improving wound healing [39]. In this study, wet nano-silver polyurethane dressing was used to treat the wound of patients undergoing gynecological surgery, which significantly shortened the time of wound healing, reduced the dressing change frequency, and alleviated pain at the wound site. This led to a faster recovery and reduced inflammatory response, making it worthy of clinical application. The statistics of postoperative adverse reactions also showed that there was no wound infection after using nano-silver polyurethane dressing, while there was one case of wound infection in the control group, this reveals that nano-silver polyurethane has good antibacterial effect. However, due to the small number of patients in this study, there was no significant difference between the two groups. This study is generally consistent with the findings of Zhang et al. [40].

Conclusion

In summary, for gynecological surgery under epidural anesthesia, dexmedetomidine exhibits minimal impact on hemodynamics while providing effective anesthesia and sedation. It is associated with a low incidence of adverse reactions and significantly enhances the quality of postoperative recovery, making it is suitable for gynecological surgery. Additionally, the postoperative application of wet nano-silver polyurethane dressing accelerates wound healing, reduces the frequency of dressing changes, alleviates inflammatory responses, and decreases the likelihood of wound infections. The limitation of this study is that it is a retrospective study with a small sample size, so large-scale and prospective clinical practice is still needed.

Disclosure of conflict of interest

None.

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References

[1] Robinson DH and Toledo AH. Historical development of modern anesthesia. J Invest Surg 2012; 25: 141-149.
[2] Hu Q, Liu X, Wen C, Li D and Lei X. Remimazolam: an updated review of a new sedative and anaesthetic. Drug Des Devel Ther 2022; 16: 3957-3974.
[3] Seki H, Furumoto K, Sato M, Kagoya A, Hashimoto H, Sekiguchi Y and Nakatsuka I. Effects of epidural anesthesia on postoperative nausea and vomiting in laparoscopic gynecological surgery: a randomized controlled trial. J Anesth 2018; 32: 608-615.
[4] Liu Y, He S and Zhou S. Effect of general anesthesia combined with epidural anesthesia on circulation and stress response of patients undergoing hysterectomy. Am J Transl Res 2021; 13: 5294-5300.
[5] Yousef AA, Salem HA and Moustafa MZ. Effect of mini-dose epidural dexmedetomidine in elective cesarean section using combined spinal-epidural anesthesia: a randomized double-blinded controlled study. J Anesth 2015; 29: 708-714.
[6] Panahi Y, Dehcheshmeh HS, Mojtahedzadeh M, Joneidi-Jafari N, Johnston TP and Sahebkar A. Analgesic and sedative agents used in the intensive care unit: a review. J Cell Biochem 2018; 119: 8684-8693.
[7] Devlin JW and Roberts RJ. Pharmacology of commonly used analgesics and sedatives in the ICU: benzodiazepines, propofol, and opioids. Crit Care Clin 2009; 25: 431-449.
[8] Durrmeyer X, Vutskits L, Anand KJ and Rimensberger PC. Use of analgesic and sedative drugs in the NICU: integrating clinical trials and laboratory data. Pediatr Res 2010; 67: 117-127.
[9] Sheen MJ and Ho ST. Dexmedetomidine: more than a sedative and analgesic. Acta Anaesthesiol Taiwan 2008; 46: 149-150.
[10] Keating GM. Dexmedetomidine: a review of its use for sedation in the intensive care setting. Drugs 2015; 75: 1119-1130.
[11] Zhang X, Wang D, Shi M and Luo Y. Efficacy and safety of dexmedetomidine as an adjuvant in epidural analgesia and anesthesia: a systematic review and meta-analysis of randomized controlled trials. Clin Drug Investig 2017; 37: 343-354.
[12] Feng Y and Zhou L. Risk analysis of poor wound healing in forceps delivery. J Obstet Gynaecol Res 2021; 47: 3509-3515.
[13] Charoenkwan K, Chotirosniramit N and Rerkasem K. Scalpel versus electrosurgery for ab-

dominal incisions. Cochrane Database Syst Rev 2012; 6: CD005987.
[14] Elangwe CN, Morozkina SN, Olekhnovich RO, Krasichkov A, Polyakova VO and Uspenskaya MV. A review on chitosan and cellulose hydrogels for wound dressings. Polymers (Basel) 2022; 14: 5163.
[15] Forni C, Gazineo D, Allegrini E, Bolgeo T, Brugnolli A, Canzan F, Chiari P, Evangelista A, Grugnetti AM, Grugnetti G, Guberti M, Matarese M, Mezzalira E, Pierboni L, Prosperi L, Sofritti B, Tovazzi C, Vincenzi S, Zambiasi P, Zoffoli C and Ambrosi E; Multischiume Group. Effectiveness of a multi-layer silicone-adhesive polyurethane foam dressing as prevention for sacral pressure ulcers in at-risk in-patients: randomized controlled trial. Int J Nurs Stud 2022; 127: 104172.
[16] Rather AH, Khan RS, Wani TU, Rafiq M, Jadhav AH, Srinivasappa PM, Abdal-Hay A, Sultan P, Rather SU, Macossay J and Sheikh FA. Polyurethane and cellulose acetate micro-nanofibers containing rosemary essential oil, and decorated with silver nanoparticles for wound healing application. Int J Biol Macromol 2023; 226: 690-705.
[17] Liu M, Liu T, Chen X, Yang J, Deng J, He W, Zhang X, Lei Q, Hu X, Luo G and Wu J. Nano-silver-incorporated biomimetic polydopamine coating on a thermoplastic polyurethane porous nanocomposite as an efficient antibacterial wound dressing. J Nanobiotechnology 2018; 16: 89.
[18] Practice Guidelines for Moderate Procedural Sedation and Analgesia 2018: A Report by the American Society of Anesthesiologists Task Force on Moderate Procedural Sedation and Analgesia, the American Association of Oral and Maxillofacial Surgeons, American College of Radiology, American Dental Association, American Society of Dentist Anesthesiologists, and Society of Interventional Radiology. Anesthesiology 2018; 128: 437-479.
[19] Mondello E, Siliotti R, Noto G, Cuzzocrea E, Scollo G, Trimarchi G and Venuti FS. Bispectral index in ICU: correlation with Ramsay Score on assessment of sedation level. J Clin Monit Comput 2002; 17: 271-277.
[20] Scheib SA, Thomassee M and Kenner JL. Enhanced recovery after surgery in gynecology: a review of the literature. J Minim Invasive Gynecol 2019; 26: 327-343.
[21] Kuramochi K, Osuga Y, Yano T, Momoeda M, Fujiwara T, Tsutsumi O, Tamai H, Hanaoka K, Koga K, Yoshino O and Taketani Y. Usefulness of epidural anesthesia in gynecologic laparoscopic surgery for infertility in comparison to general anesthesia. Surg Endosc 2004; 18: 847-851.
[22] Kang Y, Ni J and Wu L. Dexmedetomidine sedation combined with epidural anesthesia for laparoscopy in a patient with suspected tuberculosis: a case report. Medicine (Baltimore) 2018; 97: e12144.
[23] Jakob SM, Ruokonen E, Grounds RM, Sarapohja T, Garratt C, Pocock SJ, Bratty JR and Takala J; Dexmedetomidine for Long-Term Sedation Investigators. Dexmedetomidine vs midazolam or propofol for sedation during prolonged mechanical ventilation: two randomized controlled trials. JAMA 2012; 307: 1151-1160.
[24] Hughes CG, Mailloux PT, Devlin JW, Swan JT, Sanders RD, Anzueto A, Jackson JC, Hoskins AS, Pun BT, Orun OM, Raman R, Stollings JL, Kiehl AL, Duprey MS, Bui LN, O'Neal HR Jr, Snyder A, Gropper MA, Guntupalli KK, Stashenko GJ, Patel MB, Brummel NE, Girard TD, Dittus RS, Bernard GR, Ely EW and Pandharipande PP; MENDS2 Study Investigators. Dexmedetomidine or propofol for sedation in mechanically ventilated adults with sepsis. N Engl J Med 2021; 384: 1424-1436.
[25] Afonso J and Reis F. Dexmedetomidine: current role in anesthesia and intensive care. Rev Bras Anestesiol 2012; 62: 118-133.
[26] Chang ET, Certal V, Song SA, Zaghi S, Carrasco-Llatas M, Torre C, Capasso R and Camacho M. Dexmedetomidine versus propofol during drug-induced sleep endoscopy and sedation: a systematic review. Sleep Breath 2017; 21: 727-735.
[27] Yang Y, Song C, Song C and Li C. Addition of dexmedetomidine to epidural morphine to improve anesthesia and analgesia for cesarean section. Exp Ther Med 2020; 19: 1747-1754.
[28] Li H, Zhao Q, Yu Y and Li W. Clinical observation of different dosages of dexmedetomidine combined with a target-controlled infusion of propofol in hysteroscopic submucosal myomectomy. Front Surg 2023; 9: 1025592.
[29] Yang A and Gao F. Effect of dexmedetomidine combined with propofol on stress response, hemodynamics, and postoperative complications in patients undergoing laparoscopic cholecystectomy. Am J Transl Res 2021; 13: 11824-11832.
[30] Weerink MAS, Struys MMRF, Hannivoort LN, Barends CRM, Absalom AR and Colin P. Clinical pharmacokinetics and pharmacodynamics of dexmedetomidine. Clin Pharmacokinet 2017; 56: 893-913.
[31] Zeng W, Chen L, Liu X, Deng X, Huang K, Zhong M, Zhou S, Zhan L, Jiang Y and Liang W. Intranasal dexmedetomidine for the treatment of pre-operative anxiety and insomnia: a prospective, randomized, controlled, and clinical trial. Front Psychiatry 2022; 13: 816893.

[32] Bosch OG, Dornbierer DA, Bavato F, Quednow BB, Landolt HP and Seifritz E. Dexmedetomidine in psychiatry: repurposing of its fast-acting anxiolytic, analgesic and sleep modulating properties. Pharmacopsychiatry 2023; 56: 44-50.
[33] Zhang Q, Zhen J, Hui Z, Meng X, Guan J, Zhang H and Zhang J. Effect of dexmedetomidine on oxytocin-induced uterine contraction during optimal caesarean section anaesthesia. Basic Clin Pharmacol Toxicol 2022; 131: 53-59.
[34] Metzger S. Clinical and financial advantages of moist wound management. Home Healthc Nurse 2004; 22: 586-590.
[35] Wang L, Duan L, Liu G, Sun J, Shahbazi MA, Kundu SC, Reis RL, Xiao B and Yang X. Bioinspired polyacrylic acid-based dressing: wet adhesive, self-healing, and multi-biofunctional coacervate hydrogel accelerates wound healing. Adv Sci (Weinh) 2023; 10: e2207352.
[36] Cheng H, Shi Z, Yue K, Huang X, Xu Y, Gao C, Yao Z, Zhang YS and Wang J. Sprayable hydrogel dressing accelerates wound healing with combined reactive oxygen species-scavenging and antibacterial abilities. Acta Biomater 2021; 124: 219-232.
[37] Pickles S, McAllister E, McCullagh G and Nieroba TJ. Quality improvement evaluation of postoperative wound dressings in orthopaedic patients. Int J Orthop Trauma Nurs 2022; 45: 100922.
[38] Luo H, Li N, Li D and Xu L. Teaching research on using nano silver ion dressing in clinical nursing of surgically infected wounds. Cell Mol Biol (Noisy-le-grand) 2022; 68: 270-281.
[39] Pant B, Park M and Park SJ. One-step synthesis of silver nanoparticles embedded polyurethane nano-fiber/net structured membrane as an effective antibacterial medium. Polymers (Basel) 2019; 11: 1185.
[40] Zhang D, Yao D, Ma R, Nan S, Lv Y, Zhu Y and Zhu S. Effect of silver nanoparticles with thermoplastic polyurethane on postoperative rehabilitation of diabetic patients with open fracture of lower extremities. Front Surg 2022; 9: 954155.