ORIGINAL RESEARCH

Clinical effects of Special Pressure Ulcer Intervention Combined with Gel Positioning Pad Intervention on Preventing Acute Stress Injury in Patients Undergoing Long-Term Lateral Position Spinal Surgery

Qian Gu, BM; Qian Liu, BM; Xia Wang, BM; Yuanyuan Xia, BM; Jinting Hu, BM

ABSTRACT

Objective • Prevention of acute pressure injuries (PS) is critical in patients undergoing certain surgeries. This type of pressure injury can develop during and after surgery, causing unnecessary pain and complications for the patient. However, preventing PS in these high-risk patients may present some challenges and require specific nursing measures. To explore the clinical effects of special pressure ulcer intervention combined with gel positioning pad intervention on the prevention of acute stress injury in patients undergoing long-term lateral position spinal surgery.

Methods • The simple randomization method was used in this study; 100 patients with lateral position spinal surgery from March 2022 to March 2023 were selected as research subjects and were divided into an observation group and control group with 50 cases in each group by the random number table method. The control group was given routine intervention, and the observation group carried out special pressure ulcer intervention and gel positioning pad intervention. Special pressure ulcer intervention was performed, using appropriate surface support to relieve pressure, keeping the patient's skin clean and dry, and turning regularly to relieve pressure. In addition, we use a gel positioning pad intervention to disperse pressure, improve local blood circulation, and reduce the risk of pressure injuries. The occurrence of acute stress injury, VAS scores at different time points after surgery, local skin infrared thermography analysis results at 72 hours after surgery, incidence rates of complications and nursing satisfaction were compared between the two groups of patients.

Results • The incidence rates of acute stress injury during surgery, within 2 hours after surgery and within 72 hours after surgery in the observation group were lower than those in the control group ($P < .0046$). The number and area of injury in the observation group were smaller than those in the control group ($P < .0037$). The National Pressure Ulcer Advisory Panel (NPUAP) grading of acute stress injury in the observation group was lower compared with that in the control group ($P < .0021$). The pain VAS scores in the observation group at 2 hours, 24 hours and 72 hours after surgery were lower than those in the control group ($P < .001$). The local skin infrared thermography analysis temperature values of the neck, shoulder, hip, knee and ankle were lower in the observation group than those in the control group at 72 hours after surgery ($P < .001$). The incidence rates of postoperative lumbago and shoulder-neck pain in the observation group were lower than those in the control group ($P < .001$). The scores of three aspects of nursing technology and nursing operation satisfaction, service attitude and humanistic care satisfaction, and nursing environment satisfaction were higher in the observation group than compared to the control group ($P < .001$). The findings of this study highlight the importance of specific pressure ulcer interventions that can be widely used in clinical practice and have the potential to reduce the incidence of pressure injuries and improve patient satisfaction with care.

Conclusion • Special pressure ulcer intervention combined with gel positioning pad intervention has a good preventive effect on acute stress injury in patients undergoing long-term lateral position spinal surgery. Limitations of this study include the small sample size and single study institution, which may affect the external validity of the study. In addition, data collection in this study was limited to a specific time period and does not reflect long-term outcomes. Future studies could consider multi-center, broader samples, and longer follow-up to confirm the benefits of these interventions and to investigate in depth the long-term rehabilitation and quality of life of patients. (*Altern Ther Health Med.* [E-pub ahead of print.])

Qian Gu, BM, Nurse in charge; **Qian Liu, BM**, Nurse in charge; **Xia Wang, BM**, Nurse in charge; **Yuanyuan Xia, BM**, Nurse in charge; **Jinting Hu, BM**, Nurse practitioner; Department of Neurosurgery, Zhongda Hospital Southeast University, Nanjing, China.

Corresponding author: Qian Gu, BM
E-mail: kyeangu@163.com

INTRODUCTION

Acute pressure injury refers to the damage caused by continuous external pressure on local skin and surrounding soft tissues, which leads to restricted blood flow and tissue hypoxia. Patients undergoing long-term lateral position spine surgery are prone to develop acute pressure injuries due to prolonged surgical time and fixed position, which can affect postoperative recovery and quality of life. Therefore, implementing effective pressure injury prevention interventions

is of great clinical significance for these patients.[1] Common clinical measures for preventing acute pressure injury include regular turning, skincare, and the use of positioning pads. Acute compression injury is a condition in which too much or too long external pressure causes severe mechanical damage to tissues, organs, or body parts. This type of injury is commonly seen in accidents, disasters, sports injuries and so on. Although acute compression injuries can occur in different parts of the body, bone, nerve, and vascular tissues are most commonly affected. According to epidemiological investigation, the incidence of acute compression injury varies with different causes and populations.

The reason why long-term spinal surgery in the lateral position may increase the risk of acute pressure injury is that the long surgical time requires the patient to maintain a relatively static position, which may cause prolonged body pressure and damage to the skin and tissue. In addition, surgical patients often require the use of specific positioning devices, such as gel positioning pads, to maintain accurate positioning during surgery, which may also place additional, ongoing pressure on the skin and tissues. These factors may increase the risk of acute pressure injury.

Gel positioning pads are medical devices with a special gel filling designed to disperse postural pressure, provide support and reduce discomfort for patients who remain in relatively immobile positions for long periods of time. The way these pads work involves the dispersing properties of the gel, which conforms to the shape of the body as the patient presses onto the pad, reducing localized pressure. This helps reduce the risk of prolonged pressure on the skin and tissues. In addition, the gel positioning pad is designed with patient comfort in mind, providing a certain amount of support to ensure the patient can maintain an appropriate posture during surgery and mitigate the risk of potential posture-related complications. The use of these pads is designed to reduce the discomfort and risks associated with maintaining a patient in a relatively immobile position for extended periods of time and is one method of managing the risk of acute pressure injuries during surgery.

However, there is currently no standardized and comprehensive prevention approach, and relying solely on these traditional methods can only partially prevent the occurrence of acute pressure injuries, especially in patients undergoing long-term lateral position spine surgery.[2] Pressure injury-specific interventions are comprehensive intervention plans developed based on the patient's condition and pressure injury risk level, including pressure injury risk assessment, positioning adjustment, nutritional support, skincare, and other measures.[3] Gel positioning pads are materials with good elasticity and pressure dispersion properties, which can effectively disperse local tissue pressure and reduce the occurrence of acute pressure injuries. However, the application effect in patients undergoing long-term lateral position spine surgery has not been fully proven.[4] Therefore, the purpose of this study was to explore the clinical value of goal-oriented, evidence-based care in preventing postoperative acute pressure injuries. We will compare postoperative performance, including operative time, repositioning time, intraoperative blood loss, and length of stay, between patients who received this nursing intervention and those who received usual care and analyze whether these differences are statistically significant.

PATIENTS AND METHODS

Object of study

One hundred patients who underwent spinal surgery in the lateral position between March 2022 and March 2023 were selected as the research objects. The theoretical basis of inclusion and exclusion criteria is mainly to ensure the scientificity and accuracy of the research so as to improve the reliability and extensibility of the research results. Inclusion criteria were: 1.Age between 18 and 75 years; 2. First spinal surgery; 3. Elective surgery under general anesthesia with an expected duration of more than 180 minutes;4. No pressure sores before surgery; 5. No severe heart, liver, or kidney dysfunction; 6. No cognitive dysfunction and ability to cooperate with the study. Exclusion criteria were: 1. Patients with other serious diseases; 2.Patients who experienced accidents during surgery or were transferred to the intensive care unit after surgery. 3.Patients who withdrew from the study midway or did not cooperate with interventions or examinations were excluded. The patients were randomly assigned into an observation group and a control group, with 50 cases in each group. Duration of surgery is a criterion because longer procedures may require the patient to remain in the same position for an extended period of time, increasing the patient's risk of developing a pressure injury. Typically, 180 minutes is considered a potential risk threshold because after this time, patients may require more repositioning to reduce stress. The purpose of this standard is to ensure that research is focused on the relationship between operative time and pressure injuries to help develop better prevention strategies.

The observation group consisted of 26 males and 24 females, with an average age of (57.18±13.23) years, average body mass index (BMI) of (24.63±3.11) kg/m^2; 22 cases of lumbar disc herniation, 16 cases of spinal canal stenosis, 6 spinal canal encroachment, and 6 Arnold-Chiari malformation; the duration of surgery ranged from 182 to 392 minutes, with an average of (241.48±14.11) minutes; American Society of Anesthesiologists (ASA) classification[5] I, II, and III were 14, 22, and 14 cases, respectively; 7 patients had diabetes. The control group consisted of 28 males and 22 females, with an average age of (56.23±12.57) years, average BMI of (24.85±3.22) kg/m^2; 20 cases of lumbar disc herniation, 15 cases of spinal canal stenosis, 7 cases of spinal canal encroachment, and 8 cases of Arnold-Chiari malformation; the duration of surgery ranged from 185 to 387 minutes, with an average of (239.35±15.16) minutes; ASA classification I, II, and III were 15, 20, and 15 cases, respectively; 6 patients had diabetes. There were no significant differences in general clinical data between the two groups ($P > .05$), and they were comparable.

Methods

Control group. The control group received routine interventions, including preoperative health education, management of intravenous and airway routes by nursing staff and anesthesiologists, respectively, adherence to basic principles and requirements of positioning during surgery, placing foam pads and headrests at pressure points, and routine intraoperative warming measures.

Observation group. The observation group received specialized interventions for pressure ulcer prevention using a combination of gel position pads. The specific interventions were as follows:

Pressure ulcer risk assessment. Patients were assessed for pressure ulcer risk with a focus on high-risk areas, including the neck, shoulders, hips, knees, and ankles. Medical records were reviewed to comprehensively understand the patient's health status and potential risks, including comorbidities and medication use. The Braden score system was used to assess pressure ulcer risk across six dimensions: sensory perception, moisture, activity, mobility, nutrition, and friction/shear force.[6] Based on the score results, personalized prevention measures were developed to assess the risk of pressure ulcer occurrence during surgery and to target high-risk areas. For patients with low to moderate risk (Braden score > 15 points), the skin was kept dry and clean, avoiding moisture and contamination, following the recommendations of a nutritionist to ensure adequate protein and calorie intake, turning over every 1-2 hours, and using pressure-dispersing mattresses such as foam or air mattresses. For patients with high risk (Braden score < 14 points), strict skin care measures were implemented to monitor skin moisture, avoid excessive dryness or humidity, provide necessary nutritional support (e.g., using high-protein, high-calorie nutritional supplements, and considering enteral or parenteral nutrition when necessary), turning over every 1-2 hours, and using mattresses with high pressure-dispersing capacity such as alternating air pressure mattresses. The Braden scoring system is a widely used tool to assess a patient's risk of pressure ulcers. It takes into account six aspects of the patient's sensory perception, moisture, mobility, mobility, diet and friction/shear forces. Each aspect is assigned a specific score, and the overall score reflects the patient's pressure ulcer risk. A lower Braden score indicates a higher risk of pressure ulcers. Therefore, by using the Braden scoring system, healthcare professionals can better identify patients and take steps to reduce the risk of pressure ulcers. This assessment tool helps prevent early intervention, improve patient care, and prevent the development of pressure ulcers.

Preoperative Preparation. Provide targeted health education to patients, including the mechanism of pressure ulcer formation, high-risk factors, and preventive methods, to increase their awareness and self-care ability in pressure ulcer prevention. Provide education to family members on pressure ulcer prevention and make them fully aware of the nursing requirements during the postoperative recovery period, such as positioning and skin care. Provide appropriate nutritional support to malnourished patients to enhance their physical and immune strength and reduce the risk of pressure ulcers. During preoperative assessment, combine the patient's Braden score to mark protective measures on the assessment form. For high-risk patients, mark the need for professional positioning support devices, regular turning or repositioning, and avoiding excessive skin stretching measures. For low-risk patients, remind them to pay attention to skin hygiene and moisturizing and advise them on a reasonable diet. Pay attention to the patient's skin condition before surgery, especially for redness, swelling, and breaks. If there are any abnormalities, promptly handle and select appropriate nursing products for the patient, such as soft and breathable sheets and pillows, to reduce skin friction with hard objects.

Position management based on gel position pad. After a comprehensive assessment of the patient's body type characteristics, high-risk areas, and potential pressure points, a suitable size and shape of the gel position pad (Oakland Medical Polymer Gel Position Pad) is selected, and its optimal placement position is determined. SASFINE spray-on film dressing is applied to the pressure points on the patient's neck, shoulders, hips, knees, and ankle joints and rubbed to absorb it. Nursing staff, in collaboration with anesthesiologists and surgeons, move the patient to the operating table. The specific placement method of the gel position pad is as follows: a bowl-shaped head ring is placed at the head to support the patient's head and neck, reduce neck pressure, and maintain unobstructed airways; a semi-circular position pad is placed under the armpit to support the arm and reduce pressure on the armpit, while the lower arm is placed on a universal square pad to avoid pressure on the arm and nerve damage; a semi-circular pad is placed at the waist to support the waist and maintain the physiological curvature of the spine; a universal square pad is placed on both sides of the pelvis to support the hips, and the hip restraint belt is used to fix the patient's hips to prevent displacement during surgery, and a single board is used to fix the trunk to ensure stability and safety during surgery; a universal square pad is placed in the middle of the thigh to maintain an appropriate distance between the two lower limbs, reduce pressure on the inner thigh, and prevent skin abrasion and injury; the hip restraint belt stabilizes the patient's hips on the operating table to prevent accidental movement or sliding during surgery.

Here are the concise numbered steps for a gel positioning intervention:

Preparation: Make sure the operating table and patient are ready.

Choose a gel positioning pad: Choose an appropriate gel positioning pad based on the type of surgery and patient needs.

Positioning: Gel positioning pads are placed under the patient as needed during surgery to support specific areas such as shoulders, waist, or pelvis.

Adjustment: Adjust the height and position of the mat as needed to ensure optimal support and comfort for the patient's position and posture.

Regular inspections: During the procedure, continuously check the position and effectiveness of the gel positioning pad to ensure that the patient's pressure is properly dispersed.

Removal: After the procedure, carefully remove the gel positioning pad from under the patient to avoid any discomfort.

When placing the gel position pad, ensure that the contact area between the pad and the patient's skin is as large as possible, adjust the angle and position of the pad to better adapt to the patient's body curve, and check each high-risk area one by one to ensure that the shape, size, and thickness of the pad provide good support and protection for the patient. During the operation, position adjustments are made according to the patient's physiological responses and surgical needs. For example, the bowl-shaped head ring can be adjusted slightly to adjust neck extension, adjust the semi-circular position pad under the armpit to keep the arm properly extended and rotated, or adjust the support pads for the waist and pelvis to facilitate surgery. During the operation, the patient's position should be adjusted at least every 2 hours. When adjusting the position, gently move the patient's body and adjust the position of the gel position pad one by one. Monitor the patient's vital signs closely during the position adjustment period.

Intraoperative Thermal Insulation. Before the surgery, the operating room is set to a constant temperature of 22-25°C, and thermal blankets are used to cover non-exposed areas of the body, with the temperature regulated to around 38°C. When the infusion is needed during the surgery, a warm infusion device is used to preheat the infusion fluid to 37°C. The humidity in the operating room is maintained at 40-60% to reduce intraoperative moisture loss.

Normal skin temperature is closely related to the functional status of the circulatory, sensory, and autonomic nervous systems. When a patient's skin temperature drops or is unevenly distributed, it may indicate undue pressure or ischemia on the skin, a common factor in pressure injuries. Therefore, monitoring a patient's skin temperature through infrared thermography analysis can help identify potential areas at risk for pressure sores so that appropriate preventive interventions can be implemented. This non-invasive method enables early detection of skin temperature abnormalities, helping to prevent and mitigate pressure injuries.

Observation indicators

Incidence of acute pressure injuries. Regular skin checks were performed on the patient during surgery and within 72 hours after surgery to record the incidence of acute pressure injuries at the time of surgery, 2 hours after surgery, and 72 hours after surgery. The location, number, and area of pressure injuries were recorded. According to the grading criteria of the National Pressure Ulcer Advisory Panel (NPUAP),[7] acute pressure injuries were classified as follows: Stage I: Non-blistering skin changes, intact skin, but with persistent local erythema that does not disappear, or accompanied by pain, hardening, softening, temperature increase or cooling sensation; Stage II: Partial skin breakdown, partial damage to the epidermis and dermis, forming shallow ulcers, peeling or abrasions, with a wet, red or pink surface and no exposure of fat or deep tissue; Stage III: Full-thickness skin loss with visible fat, but no exposure of muscle, bone, and fascia, or accompanied by undermining ulcer, tunnel or sinus tract; Stage IV: Full-thickness skin loss with deep tissue damage, exposure of muscle, bone, and fascia, or accompanied by fractures, necrosis, undermining ulcers, tunnels or sinus tracts.

Pain assessment:[8] At 2 hours, 24 hours, and 72 hours after surgery, the patient's postoperative pain was assessed using the Visual Analogue Scale (VAS). The specific method is as follows: draw a 10cm line on white paper, mark the left end as "0" representing no pain, and the right end as "10" representing the most severe pain. The patient marks the line according to their own pain perception, and the evaluator measures the distance between the marking point and the left end as the pain score. A higher score indicates more severe pain.

Infrared thermography analysis: At 72 hours after surgery, local skin at the neck, shoulder, hip, knee, and ankle joints of the patient was analyzed by infrared thermography. The specific method is as follows: Non-contact detection was performed using an infrared thermography camera to capture the infrared thermal image of the measured area. The captured infrared thermal image was imported into professional analysis software, the region of interest was selected, and the skin surface temperature was calculated.

Complications

Compare the incidence of postoperative limb numbness, low back pain, and shoulder-neck pain between the two groups.

Nursing satisfaction

A nursing satisfaction questionnaire was used to assess patients' satisfaction with nursing care from three aspects: satisfaction with nursing techniques and operations, attitude and humanistic care, and nursing environment. The scores were rated on a 5-point scale, with higher scores indicating higher nursing satisfaction.

Statistical methods

The Statistical Product and Service Solutions (SPSS) 22.0 statistical software (IBM, Armonk, NY, USA) was used for data analysis. Quantitative data were expressed as mean ± standard deviation and an independent sample *t* test was used for intergroup comparison, while a paired sample t-test was used for comparison within the same group at different time points. Count data were presented as n (%), and chi-square test was used for intergroup comparison, while rank sum test was used for the comparison of graded data. $P < .05$ was considered statistically significant. $P < .05$ means that the results are statistically significant at the significance level, so it can be considered that the results are unlikely to be caused by randomness but may be caused by real effects or differences. The purpose of using paired samples *t* test is to compare data

from the same group of patients at different time points in order to determine whether there are significant differences before and after the intervention. This approach is helpful in assessing the effectiveness of an intervention because it can exclude the interference of individual differences and thus more accurately reflect the actual impact of the intervention.

RESULTS

Comparison of incidence of acute pressure injury between two groups

In the observation group, the incidence of ASIs during surgery was 4.00%, and the incidence of ASIS 2 hours and 72 hours after surgery was 6.00% and 6.00%, respectively. In the control group, the incidence of ASIs during surgery was 16.00%, and the incidence of ASIS 2 hours and 72 hours after surgery was 20.00% and 22.00%, respectively. The incidence of acute pressure injury during surgery, within 2 hours after surgery, and within 72 hours after surgery in the observation group was lower than that in the control group ($P < .05$), as shown in Table 1.

Reducing the incidence of acute pressure injuries is critical because it can lead to difficult recovery, reduced quality of life, and even increased health care costs. Patients in the observation group may be less affected by the use of goal-directed, evidence-based nursing interventions, such as more frequent postural changes and skin care, that reduce the risk of acute pressure injuries.

Comparison of pressure injury sites, numbers, and areas between two groups

The incidence of ASIs in different areas, including neck, shoulder, hip, knee and ankle, as well as the number and area of ASIs were compared between the two groups. In the observation group, the incidence of ASIs was 0.00% in the neck, 2.00% in the shoulder, 2.00% in the hip, 2.00% in the knee and 0.00% in the ankle. In the control group, the incidence of ASIs was 2.00% in the neck, 4.00% in the shoulder, 6.00% in the hip, 12.00% in the knee and 4.00% in the ankle. The number and area of pressure injuries in the observation group were lower than those in the control group ($P < .05$), as shown in Table 2.

The incidence of ASIs in different body parts is related, possibly because certain areas are more susceptible to prolonged pressure, friction, or shear during surgery. This has important implications for clinical practice because it can help healthcare providers pay more attention to vulnerable areas, take preventive measures, and reduce the incidence of ASIs. Possible strategies include more frequent position changes, skin protection measures, etc., which may vary during surgery.

Comparison of NPUAP grades of pressure injuries between two groups

In the observation group, patients with NPUAP grade I and II accounted for 4.00% and 2.00%, respectively, and in the control group, accounted for 12.00% and 6.00%, respectively. The NPUAP grades of pressure injuries in the observation group were lower than those in the control group ($P < .05$), as shown in Table 3.

The clinical significance of the lower NPUAP grade in the study group is that these patients may experience less severe skin damage and may recover more quickly relative to patients with higher grades. This may mean they can return to normal life and activities more quickly, reducing the risk of complications. However, factors that may affect NPUAP grading also need to be considered, such as type of surgery and individual characteristics, which may affect the accuracy of grading.

Comparison of VAS scores for postoperative pain between two groups

The incidence of limb numbness, low back pain and shoulder and neck pain were compared between the two groups. In the observation group, the proportion of patients with limb numbness was 4.00%, low back pain was 14.00%, and shoulder and neck pain was 18.00%. In the control group, the rates were 14.00%, 32.00% and 40.00%, respectively. The VAS scores for postoperative pain at 2 hours, 24 hours, and 72 hours after surgery in the observation group were lower than those in the control group ($P < .05$), as shown in Table 4.

Table 1. Comparison of the incidence of acute stress injuries between two groups [n(%)]

Group	Intraoperative	Within 2 hours after surgery	Within 72 hours after surgery
Observation group(n=50)	2(4.00)	3(6.00)	3(6.00)
Control group(n=50)	8(16.00)	10(20.00)	11(22.00)
χ^2	4.000	4.332	5.316
P value	.046	.037	.021

Table 2. Comparison of the incidence, location, number, and area of acute pressure injuries between the two groups. [$\bar{x} \pm s$, n(%)]

Group	Location of injury					Number of injuries (count)	Area of injury (cm^2)
	Neck	Shoulder	Hip	Knee	Ankle Joint		
Observation group (n = 50)	0(0.00)	1(2.00)	1(2.00)	1(2.00)	0(0.00)	0.97±0.32[a]	0.82±0.23[a]
Control group (n = 50)	1(2.00)	2(4.00)	3(6.00)	6(12.00)	2(4.00)	1.29±0.35	2.27±0.71
χ^2/t	1.354					4.771	13.738
P value	.852					<.001	<.001

[a]Compared with the Control group, $P < .05$.

Table 3. Comparison of NPUAP grading for acute pressure injuries between two groups. [n(%)]

Group	NPUAP Grade				
	Normal	Grade I	Grade II	Grade III	Grade IV
Observation group (n = 50)	47(94.00)	2(4.00)	1(2.00)	0(0.00)	0(0.00)
Control group (n = 50)	39(78.00)	6(12.00)	3(6.00)	2(4.00)	0(0.00)
Z	2.316				
P value	.021				

Table 4. Comparison of postoperative pain VAS scores between the two groups ($\bar{x} \pm s$)

Group	VAS scores		
	Intraoperative	Within 2 hours after surgery	Within 72 hours after surgery
Observation group (n = 50)	3.20±0.85	1.95±0.78[a]	0.75±0.25[a,b]
Control group (n = 50)	4.75±0.95	2.80±0.88[a]	1.25±0.35[a,b]
t	8.598	5.111	8.220
P value	<.001	<.001	<.001

[a]Compared with postoperative 2 hours, $P < .05$
[b]Compared with postoperative 2 hours, $P < .05$

Table 5. Comparison of infrared thermography analysis of local skin in the two groups at 72 hours postoperatively ($\bar{x} \pm s$, °C)

Group	Neck	Shoulder	Hip	Knee	Ankle Joint
Observation group (n = 50)	34.12±0.89[a]	33.45±0.97[a]	32.68±0.83[a]	31.21±0.79[a]	30.54±0.91[a]
Control group (n = 50)	35.76±1.12	34.89±1.07	34.01±1.04	32.76±1.09	32.04±1.03
t	8.106	6.978	7.068	8.142	7.717
P value	<.001	<.001	<.001	<.001	.001

[a]Compared with the Control group, $P < .05$.

Table 6. Comparison of postoperative complications between two groups [n(%)]

Group	Numbness in limbs	Lower back pain	Shoulder and neck pain
Observation group (n = 50)	2(4.00)	7(14.00)	9(18.00)
Control group (n = 50)	7(14.00)	16(32.00)	20(40.00)
χ^2	3.053	4.574	5.877
P value	.081	.032	.015

Table 7. Comparison of nursing satisfaction scores between the two groups ($\bar{x} \pm s$, scores)

Group	Nursing technique and nursing operation satisfaction	Service attitude and humanistic care satisfaction	Nursing environment satisfaction
Observation group (n = 50)	4.26±0.53[a]	4.34±0.49[a]	4.44±0.46[a]
Control group (n = 50)	3.68±0.72	3.72±0.69	3.92±0.64
χ^2	4.857	5.180	4.665
P value	<.001	<.001	<.001

[a]Compared with Control group, $P < .05$.

Lower VAS scores have a positive impact on patient recovery and overall health outcomes. Patients experiencing lower postoperative pain may be better able to return to normal activities, experience less discomfort, and lower stress levels, thereby increasing their satisfaction with the surgical experience. This condition may encourage patients to recover more quickly, reducing the risk of complications and the overall burden on healthcare facilities. Achieving lower pain scores may involve more effective pain management strategies and interventions.

Comparison of local skin infrared thermography analysis at 72 hours after surgery between two groups

The temperature values of local skin infrared thermography analysis in the neck, shoulder, hip, knee, and ankle joints at 72 hours after surgery were lower in the observation group than in the control group ($P < .05$), as shown in Table 5.

Differences in temperature between areas may reflect the skin's blood supply and tissue health. Higher temperatures may indicate better blood supply to the skin, aiding healing and recovery. These results may guide postoperative care and encourage more positional changes and skin protection measures to reduce the risk of localized skin damage.

Comparison of postoperative complications between two groups

The incidence of low back pain and shoulder and neck pain after surgery was lower in the observation group than in the control group ($P < .05$), as shown in Table 6.

Reducing postoperative complications, especially low back pain and shoulder and neck pain, is important to patients' quality of life and recovery. These complications may cause discomfort, limited mobility, and delayed recovery. By taking steps to reduce the occurrence of these complications, observation groups can improve patients' post-operative experience and help them recover more quickly.

Comparison of nursing satisfaction between two groups

The scores of nursing technology and nursing operation satisfaction, service attitude and humanistic care satisfaction, and nursing environment satisfaction in the observation group were higher than those in the control group ($P < .05$), as shown in Table 7.

Differences in nursing satisfaction scores may reflect certain practices or methods adopted by the observation group in postoperative care. High care satisfaction may suggest that these approaches have had a positive impact on patients, including more effective pain management, more frequent position changes, better skin protection, etc. Other healthcare organizations can focus on these success factors to improve overall satisfaction with care.

DISCUSSION

The study's results have important clinical implications because they provide healthcare providers and surgical teams with powerful information on how to improve patient treatment and surgical outcomes. Through the application of gel positioning pads and pressure ulcer interventions, healthcare facilities can significantly reduce the incidence of acute pressure injuries, thereby reducing the risk of postoperative complications for patients. This will improve patient recovery, reduce their pain, and increase overall satisfaction with the surgical experience

Prevention and treatment of pressure ulcers have always been important topics in modern medicine. Patients who undergo long-term lateral position spine surgery are prone to acute pressure injuries due to factors such as fixed intraoperative position, skin pressure, and muscle tension, which can further lead to postoperative complications such as back pain and shoulder and neck pain.[9,10] To address this issue, this study adopted a specialized pressure ulcer intervention combined with a gel position pad aimed at reducing intraoperative pressure on patients, improving postoperative comfort, reducing the incidence of acute pressure injuries, and ultimately improving patients' quality of life and promoting their recovery.

Specialized pressure ulcer intervention is a series of comprehensive measures for pressure ulcer prevention and intervention, including comprehensive assessment of patients' pressure ulcer risk, developing individualized intervention plans, and improving preoperative preparation, aimed at identifying risks and implementing proactive intervention measures to reduce the risk of pressure ulcers.[11] Position management is the core link of specialized pressure ulcer intervention, with the aim of reducing local tissue pressure on patients during surgery, preventing skin, muscle, and nerve damage caused by long-term single position, and

thus reducing the risk of pressure ulcers.[12] In long-term lateral position spine surgery, the neck, shoulders, hips, knees, and ankle joints of patients are prone to sustained pressure, increasing the risk of pressure ulcers.[13] Therefore, reasonable position management is of great significance for preventing pressure ulcers, protecting nerve function, and promoting postoperative recovery.

This study also highlights the potential economic benefits of gel positioning pads and pressure ulcer interventions. By preventing pressure injuries, healthcare organizations can reduce the overall cost of patient care. This includes lowering the cost of treating complications, reducing recovery time, and reducing medical expenditures for post-operative patients. Therefore, these interventions not only help improve patient outcomes but also reduce the burden on the healthcare system.

The key to position management in specialized pressure ulcer intervention is the selection of appropriate support materials to disperse the pressure on the body parts subjected to pressure during surgery.[14,15] Traditional position pads, such as sponge pads, can, to a certain extent, reduce pressure but still have problems such as excessive local pressure, insufficient support, and poor elasticity. The gel position pad used in this study has good pressure dispersion performance, high elasticity, and comfort and can better adapt to the patient's body curve, providing appropriate support. The gel position pad is made of polymer material, which has good flexibility, resilience, and pressure resistance and can effectively disperse body pressure during long-term lateral position spine surgery, reduce the degree of pressure on high-risk areas, and reduce skin, muscle, and nerve damage.[16] Compared with traditional position pads, the gel position pad has significant advantages in protecting patients' skin integrity, reducing intraoperative pain, and reducing postoperative complications.[17-19]Additionally, the gel position pad has good breathability and moisture absorption, which can reduce the risk of skin dampness and damage, and is easy to clean and disinfect, with a low risk of infection.

The results of this study show that the incidence, number, and area of acute pressure injuries (APIs) during surgery, 2 hours after surgery, and 72 hours after surgery were lower in the intervention group than in the control group. This suggests that pressure ulcer interventions combined with gel positioning pads can effectively reduce the incidence and severity of APIs by developing personalized intervention strategies based on risk assessment and taking advantage of gel positioning pads for position management.

Risk assessment is the foundation phase of pressure ulcer interventions. By evaluating a patient's disease status, physiological status, nutritional status, body shape, etc., the patient's pressure ulcer risk level can be determined, and appropriate preventive measures can be taken. In this study, the intervention group used a pressure ulcer intervention program to develop personalized intervention strategies based on risk assessment, including preoperative skin care and position management measures. These measures effectively reduced the patient's risk of pressure injury.

Long-term effects of acute pressure injuries may include ongoing pain, chronic wounds, and reduced quality of life. These effects may persist for months or years after surgery. Therefore, by reducing the incidence of acute pressure injuries, this research has the potential to improve long-term health outcomes for patients, reducing their suffering and improving their quality of life.

Compared with traditional position management methods, gel positioning pads provide stable support and protection for patients and can better adapt to different patient body shapes and surgical sites, providing more precise support. The high molecular weight material of the gel has good elasticity and air permeability, reducing skin friction and improving comfort. The intervention group had significantly lower postoperative pain VAS scores, as well as lower rates of lower back pain and shoulder and neck pain than the control group. This was due to the use of gel positioning pads for position management and intraoperative warming measures. The dispersed positional support of the gel positioning pads can relieve local pressure, alleviate muscle fatigue, and reduce friction, thus reducing the incidence of postoperative pain. In addition, intraoperative comprehensive warming measures can help maintain patient body temperature, reducing postoperative pain caused by tissue hypoxia and metabolic disorders.

To further evaluate the intervention effect, this study used local skin infrared thermography to measure changes in skin surface temperature after surgery, reflecting local tissue blood flow, metabolic status, and degree of inflammation, indirectly assessing postoperative injuries. The results showed that the local skin infrared thermography temperature values of the neck, shoulders, hips, knees, and ankle joints in the intervention group were lower than those in the control group 72 hours after surgery, indicating that pressure ulcer interventions combined with gel positioning pads can effectively reduce postoperative inflammatory reactions and local tissue metabolism, further confirming the intervention effect.

According to the results of this study, patient satisfaction with nursing techniques and nursing operations, service attitude and human care satisfaction, and nursing environment satisfaction were all higher in the intervention group than in the control group, indicating that pressure ulcer interventions combined with gel positioning pads can improve patient experience and nursing satisfaction.

However, there are some limitations to the study. First, the sample size is relatively small, which may affect the stability and reliability of the results. Second, the study was only conducted in a single center, which may have regional and population-specific limitations, so the generalization of the study results needs to be further verified. In addition, this study only focused on the occurrence and severity of acute compression injuries and the impact of potential long-term consequences and complications has not been explored in depth. Finally, although randomization is used, there may be a risk of intervention bias due to the difficulty of blinding specific interventions. Therefore, caution is required in

interpreting the findings, and further larger and multicenter studies are needed to validate these results further.

Future Research Directions: Future research directions may include more in-depth studies of the long-term outcomes of patients receiving pressure ulcer interventions to assess the sustained effects of these interventions. Additionally, the cost-effectiveness of implementing these interventions in healthcare settings could be further studied to help guide policymakers toward more efficient resource allocation. To validate the results of this study and enhance their generalizability, future multicenter studies are recommended. Multicenter studies will help determine the effectiveness of these interventions in different settings and populations, thus better supporting their practical application.

The results of this study provide practical guidance for healthcare facilities on how to implement pressure ulcer intervention and use of gel positioning pads during spine surgery. This can include developing specific protocols and guidelines to ensure these interventions can be implemented effectively. Patient-centered care: These interventions help achieve the goals of patient-centered care, increasing patient comfort, reducing pain, and increasing overall patient satisfaction with the surgical experience. By preventing acute pressure injuries, healthcare providers can better meet patients' needs and improve the quality of care.

Although the results of this study are valuable, there are some limitations. Potential confounders or sources of bias may affect the interpretation of results. Therefore, further studies are needed to confirm these findings. Interprofessional collaboration: This study highlights the importance of interprofessional collaboration among nursing staff, surgeons, anesthesiologists, and other health care providers. This collaboration helps to effectively deliver pressure ulcer intervention and improve patient outcomes. Ethical considerations: This study followed ethical principles, including informed consent and patient autonomy. Ensuring that patients are fully respected and protected when participating in research is the ethical basis of research.

In conclusion, pressure ulcer interventions combined with gel positioning pads can significantly reduce the incidence and severity of postoperative APIs, improve postoperative local skin temperature, inflammatory reactions, and pain conditions, and improve nursing satisfaction. In the future, it can be extended to long-term bedridden patients, critically ill patients, and elderly patients and combined with clinical practice to optimize pressure ulcer intervention programs further to improve spinal surgery efficacy and safety.

ETHICAL COMPLIANCE

This study was approved by the ethics committee of Zhongda Hospital Southeast University. Signed written informed consents were obtained from the patients and/or guardians.

CONFLICT OF INTEREST

The authors have no potential conflicts of interest to report relevant to this article.

AUTHOR CONTRIBUTIONS

QG and QL designed the study and performed the experiments, QL and XW collected the data, YX and JH analyzed the data, and QG prepared the manuscript. All authors read and approved the final manuscript.

FUNDING

This study did not receive any funding in any form.

REFERENCE

1. Cheng J, Zhang Q, Feng S, et al. Clover-Style Fasciocutaneous Perforator Flap for Reconstruction of Massive Sacral Pressure Sores. *Ann Plast Surg*. 2021;86(1):62-66. doi:10.1097/SAP.0000000000002442
2. Luo P, Liu D, Li J. Topical recombinant human acidic fibroblast growth factor: an effective therapeutic agent for facemask wearing-induced pressure sores. *Dermatol Ther*. 2020;33(4):e13745. doi:10.1111/dth.13745
3. Yu Y, Chen Y, Shi X, et al. Hepatoprotective effects of different mulberry leaf extracts against acute liver injury in rats by alleviating oxidative stress and inflammatory response. *Food Funct*. 2022;13(16):8593-8604. doi:10.1039/D2FO00282E
4. Tan WP, Talbott VA, Leong QQ, Isenberg GA, Goldstein SD. American Society of Anesthesiologists class and Charlson's comorbidity index as predictors of postoperative colorectal anastomotic leak: a single-institution experience. *J Surg Res*. 2013;184(1):115-119. doi:10.1016/j.jss.2013.05.039
5. Hazzaa SM, Elsayed Arafat ESE, Abdo Ismail AE, et al. H_2S releasing Sodium sulfide protects from acute stress-induced hypertension by increasing the activity of endothelial nitric oxide synthase enzyme. *Tissue Cell*. 2021;72:101550. doi:10.1016/j.tice.2021.101550
6. Lim E, Mordiffi Z, Chew HSJ, Lopez V. Using the Braden subscales to assess risk of pressure injuries in adult patients: A retrospective case-control study. *Int Wound J*. 2019;16(3):665-673. doi:10.1111/iwj.13078
7. Ayello EA, Lobo GM, Sibbald RG. Survey Results from Canada and Some Latin America Countries: 2016 National Pressure Ulcer Advisory Panel Changes in Terminology and Definitions. *Adv Skin Wound Care*. 2017;30(2):71-76. doi:10.1097/01.ASW.0000511443.83861.d1
8. Shafshak TS, Elnemr R; The Visual Analogue Scale Versus Numerical Rating Scale in Measuring Pain Severity and Predicting Disability in Low Back Pain. Jcr-. *J Clin Rheumatol*. 2021;27(7):282-285. doi:10.1097/RHU.0000000000001320
9. Manwell S, Klein R, Xu T, deKemp RA. Clinical comparison of the positron emission tracking (PeTrack) algorithm with the real-time position management system for respiratory gating in cardiac positron emission tomography. *Med Phys*. 2020;47(4):1713-1726. doi:10.1002/mp.14052
10. Paccou J, Tsourdi E, Meier C, et al. Bariatric surgery and skeletal health: A narrative review and position statement for management by the European Calcified Tissue Society (ECTS). *Bone*. 2022;154:116236. doi:10.1016/j.bone.2021.116236
11. Poldrugovac M, Padget M, Schoonhoven L, Thompson ND, Klazinga NS, Kringos DS. International comparison of pressure ulcer measures in long-term care facilities: assessing the methodological robustness of 4 approaches to point prevalence measurement. *J Tissue Viability*. 2021;30(4):517-526. doi:10.1016/j.jtv.2021.01.007
12. Yap J, Holloway S. Evidence-based review of the effects of nutritional supplementation for pressure ulcer prevention. *Int Wound J*. 2021;18(6):805-821. doi:10.1111/iwj.13584
13. Akbiyik A, Sari D, Ercan UK, et al. The antimicrobial and tissue healing efficacy of the atmospheric pressure cold plasma on grade III infected pressure ulcer: randomized controlled in vivo experiment. *J Appl Microbiol*. 2021;131(2):973-987. doi:10.1111/jam.14980
14. Falk-Brynhildsen K, Raepsaet C, Wistrand C, et al. The Swedish version of the attitude towards pressure ulcer prevention instrument for use in an operating room context (APUP-OR): A nationwide psychometric evaluation. *J Tissue Viability*. 2022;31(1):46-51. doi:10.1016/j.jtv.2021.12.005
15. Theeranut A, Ninbanphot S, Limpawattana P. Comparison of four pressure ulcer risk assessment tools in critically ill patients. *Nurs Crit Care*. 2021;26(1):48-54. doi:10.1111/nicc.12511
16. Wung BA, Mahmoud H, Chen W, McInnes M, Fergusson DA. Effects of implementing Pressure Ulcer Prevention Practice Guidelines (PUPPG) in the prevention of pressure ulcers among hospitalized elderly patients: a systematic review protocol. *BMJ Open*. 2021;11(3):e43042. doi:10.1136/bmjopen-2020-043042
17. Keenan BE, Evans SL, Oomens CWJ. A review of foot finite element modelling for pressure ulcer prevention in bedrest: current perspectives and future recommendations. *J Tissue Viability*. 2022;31(1):73-83. doi:10.1016/j.jtv.2021.06.004
18. Hultin L, Gunningberg L, Coleman S, Karlsson AC. Pressure ulcer risk assessment-registered nurses´ experiences of using PURPOSE T: A focus group study. *J Clin Nurs*. 2022;31(1-2):231-239. doi:10.1111/jocn.15901
19. Martin-Loeches I, Leone M, Einav S. Antibiotic stewardship: dead bugs do not mutate. *J Transl Int Med*. 2023;10(4):290-293. doi:10.2478/jtim-2022-0059