Journal of Nursing & Care

Xia et al., J Nurs Care 2016, 5:3
DOI: 10.4172/2167-1168.1000343

Research Article Open Access

A New Approach to Reduce Pressure Ulcers and Improve Health of Scoliosis Surgery Patients

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Received date: Mar 15, 2016; **Accepted date:** Apr 29, 2016; **Published date:** May 07, 2016

Abstract

Background: Spinal fusion is the common form of corrective surgery for scoliosis, and it is often accompanied with the occurrence of pressure ulcer development. New research and approaches are needed to address the incidence of peptic ulcer in surgical patients.

Objectives: The study was designed to reduce/prevent the incidence of pressure sores and to improve the health of patients undergoing scoliosis surgery.

Methods: 130 patients with scoliosis surgery were randomly assigned into two groups: 65 patients in the training group and control group, respectively. The patients in the training group received a pre-surgery visit with adaptive training on prone position prior to their surgery, while the control group received no such training. Surgery preparation time and total time in the surgical room were recorded for all patients. The incidence and size of red skin and pressure sores due to scoliosis surgery were also measured and recorded upon surgeries.

Results: A comparative analysis showed that a pre-surgical visit to the surgical room has significantly reduced the preparation time prior to surgery by up to 15 minutes for patients in test group, which led to an ostensible reduction of the total time for the day-of-surgery. The implementation of a pre-set optimal prone position helped test patients to reduce the incidence of pressure sores significantly from over 33.8% (control group) to less than 14% (test group, $p<0.05$). In particular, the optimal setting of the prone position with soft gel pats and cushion has effectively protected patients from serious facial damage as a result of a lengthy surgical process.

Conclusion: A simple arrangement of a pre-surgical visit with adaptive training for optimal prone position to scoliosis patients could have important impacts on reducing the incidence of pressure sore and improving patients' health condition.

Keywords: Pre-surgical visit; Prone position; Scoliosis surgery; Pressure ulcer; Pressure sore

Introduction

Scoliosis is a medical condition affecting 5-7 million people in the United States [1]. The condition is characterized by a three dimensional deformity in one's spinal axis which includes serial coronal, sagittal and axial positions exception [2]. Affected individuals often display an S- or C-shaped curve in the spine, unlike the straightness of a normally developed spine. Scoliosis is currently grouped into congenital and idiopathic two categories based on causes [3]. Among all scoliosis cases, the majority (>65%) are idiopathic [4]. Nearly 85% of scoliosis cases are found in children and adolescents aging between 10-15 years old. Scoliosis is also more prevalent in females than in males [2].

Treatment for affected scoliosis patients varies depending on age and severity of the curvature, skeletal maturity, and the potential risk of curvature progression [5]. Surgery and bracing are two current treatments options available to scoliosis patients. Corrective surgery is usually recommended to severe scoliosis cases with at least a 40-degree curvature. The surgery is also performed if standard activities are seriously, or anticipated to be seriously, affected by the curvature, such as breathing. Currently, posterior fusion has been the common type of surgery performed to treat scoliosis and is conducted through an incision on the back and involves the use of metal instrumentation and anesthesia to correct the curvature while the patient lies in prone position. Since the posterior fusion procedure usually takes 4-8 hrs on average [6-8] and lying in prone position during the lengthy procedure under general anesthesia often leads to complications among different parts of the patient's body, most notably pressure ulcers (PU) on the forehead [6,9-11].

Current studies have suggested that hours spent in non-optimal prone positioning on a surgical bed to be the main cause of pressure sores. This study was conducted to test and evaluate a simple intervention to reduce pressure ulcers by implementing a pre-surgery visit which allow to consultation with the surgical nursing staff and personalized prone position placement to make the patient more comfortable before and during the surgery. The overall purpose of this study was to explore feasibility of a pre-surgical visit to surgery rooms

as an intervention approach to scoliosis patients for the prevention of pressure ulcer occurrence.

Methods

Participants

The participant population of this case control study consisted of 180 patients enrolled in Tongji Hospital in Wuhan, China between November 2012 and November 2014 for three-dimensional scoliosis orthopedic surgery. However, only 130 patients were included in this study basing on the inclusion criteria of the study: congenital and idiopathic scoliosis patients with age ≤ 35 years old, surgical correction of lesion ≥ 3 segments, an cobb angle (curvature) ≥ 40° Of these participants, 58 were males and 72 were females with an age range of 6.2 to 35 years. To test if a pre-surgical visit intervention would help to reduce surgery associated pressure ulcers (PU), the surgery patients were randomly assigned into two groups according to a random number table: 65 patients were classified into the test group while the other 65 were assigned into the control group. The patients of test group received the pre-surgical visit to surgery rooms with adaptive training on prone position prior to their surgery and the patients of the control group did not receive the pre-surgery visit. The demographics of these patients are summarized in Table 1.

No.	Characteristics	Test group n (%)	Control group n (%)	Statistic value	P value
1	Sex			$\chi 2=0.166$	p>0.05
	Male	30 (46.15)	28 (43.08)		
	Female	35 (53.85)	37 (56.92)		
2	Age (year) mean (sd)	15.74 ± 3.58	14.48 ± 4.73	t =1.35	p>0.05
3	Scoliosis type			$\chi 2=0.166$	p>0.05
	Congenital	17 (26.15)	15 (23.08)		
	Idiopathic	48 (73.85)	50 (76.92)		
4	Body characteristics				
	Height (cm) mean (sd)	147.48 ± 25.89	158.61 ± 8.69	t =-1.95	p>0.05
	Weight (kg) Mean (sd)	45.50 ± 11.82	45.55 ± 8.02	t =-0.015	p>0.05
5	Occupation			$\chi 2=0.967$	p>0.05
	Student	45 (69.2%)	46 (70.8%)		
	Farmers	5(7.7%)	3 (4.6%)		
	Freelance	11 (16.9%)	10 (15.4%)		
	Unemployed	4 (6.2%)	6 (9.2%)		
6	Marital Status				
	Single	57 (87.7%)	55 (84.6%)		
	Married	8 (12.3%)	10 (15.4%)		
7	No. days in Hospital Mean (sd)	17.50 ± 7.57	22.18±7.29	t =-2.089	p<0.05*

Table 1: General information of participating surgery patients (n = 130), *P<0.05 – two groups showing statistically significant difference.

Pre-surgical visit intervention

Three days prior to surgery, scoliosis patients of the test group were guided to visit the surgical room where their surgery was to be performed, to meet with the surgical staff, and to conduct an adaptive training for most comfortable prone positioning.

Familiar with surgical environment: One purpose for the pre-surgical visit to surgical room is to allow surgical patients to get familiar with the surgical environment through their personal visiting to the surgical room and meeting with surgical nurses and medical staff. At first, the patients were introduced to surgical nurses and medical staff to be working for his/or her surgery. Patients were then brought into the surgical room to gain familiarity with the environment. A short discussion between patients and the nurses followed including asking questions to clarify any concerns about their

surgery with the aim of reducing stress, fear, strangeness, anxiety and discomfort on the day of the surgery.

Understanding the surgical procedure and self-preparation: After meeting with surgical nurses in the surgical room, patients were introduced to their upcoming surgical procedure. A surgical nurse explained to patients that a typical scoliosis surgery is a time consuming and exhausting procedure and their surgery would take 6-8 hours or even longer and also the importance of adequate pre-surgical preparation by the patient. Particularly, patients were encouraged to have a good sleep the night before, to eat well before but no food 12 hours prior to their surgery, and to try to maintain deep breathing during their surgical process. Nurses provided as much information to patients as possible in order to ease their anxiety and discomfort on the day of the surgery. Surgical nurses also explained in detail regarding the purpose and importance and of an adaptive training and practice for setting up the most comfortable prone position for their surgery.

Setting up prone position placement at optimal conditions: The patients were then arranged to receive adaptive training and practice for prone position. The extreme importance of proper prone position was emphasized to the patients at their visit. To test and determine a personalized optimal position for individual patients, they were asked to lie on the surgical bed at a posterior fusion position and different shapes and sizes of soft gel pads including groove horseshoe-shaped gel pads, long- and short strip gel pads, and different sizes of posture pads (Action Products, Inc., USA) were selectively tested. In particular, Patients were to head in a horseshoe prone gel pad and their chest proned on the two long elongated gel pats, and so that their trachea and bronchus were under no pressure and their airway remains open during their surgery. Proper sponge pad rings were applied to the knees and soft pad and pillows were used for the dorsum and the foot. Patient arms were naturally bent with the angle of 65-75°C (not exceeding 90°C) to ensure no excessive abduction leading to brachial plexus damage. In addition, protective measure was taken to guard breast area of female patients and the external genitalia of male patients, and to protect patients' eyes. Basing on the patient's wishes and comfort, the surgical nurses selected and adjusted use of the soft gel pads until a most comfortable setting of prone position reached (Figure 1). Patients were then asked to breathe deeply at the chosen prone position on the surgical bed for a few minutes to ensure the position established to be truly comfortable for individual patients. At the end of training and position setting, the configuration of the prone position with selected models of posture mat, gel pads, and placement for individual patient was then photographed and used on the day of their surgery. In addition, patients in test group had also received training for effective breathing and in respiratory function before surgery, including respiration breath-hold for a few seconds after the forced expiratory before a deep breathing, trying to extend the expiration time, 3 times/breath, 50 times/practice.

Evaluation of indicators and methods

Two types of evaluations were conducted in this to assess if the pre-surgical visit is beneficial to scoliosis patients.

To assess if a pre-surgical visit will reduce the stress, anxiety and fear of surgical patients, the respiration rate and heart rate were recorded at different time points for the patients of control and test groups using electric monitoring system (MP60, Philips of Germany): 1) three days prior to their surgery, 2) the time after entering into the room on surgery day, and 3) the time just prior to their surgery.

To assess if the pre-surgical visit will help to prevent and reduce the occurrence of PU development, the incidence of pressure sores of scoliosis patients were immediately evaluated and recorded for both test and control groups upon the completion of their surgery. In addition, the size of pressure ulcer on their face was measured and serious degree of pressure ulcers was carefully evaluated and recorded according to criteria described in "Pressure ulcer prevention guidelines" jointly issued by the U.S. Pressure Sores Advisory Board and the European Pressure Ulcer Advisory Boards in 2009 with I-IV four different stages of Pressure sores basing on skin damage. The total number of patients in stage I (pressured skin) (I phase), and the number of pressure ulcers (Stages II-IV) were recorded for test and control groups, respectively. The Pressure ulcer incidence rate was calculated using below formula:

Pressure ulcer incidence rate (%) = No. patients with pressure ulcers / No. of surgical patients × 100%.

Data analysis

Statistical analysis was performed using SPSS software for Windows (Version 20.0 Armonk, NY: IBM Corp) for data processing. Two types of statistical tests and related analysis were utilized to examine the proposed research aims and objectives; calculating the mean, standard deviation, and the incidence rate of pressure sores and other indicators, and verified by t test and χ^2 test. All tests were two-sided, and statistical significance was set at $p<0.05$. Repeated measure analysis of variance was also carried out in this study.

Figure 1A

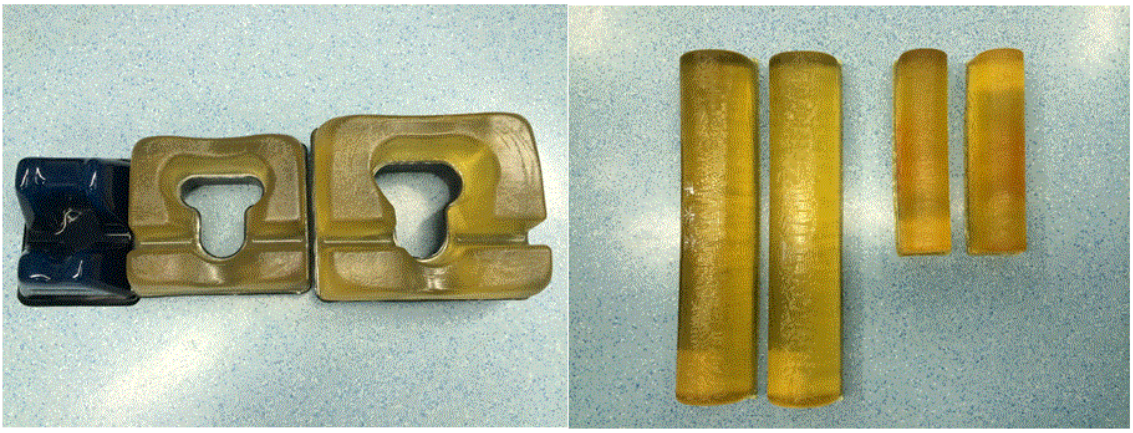

Figure 1B

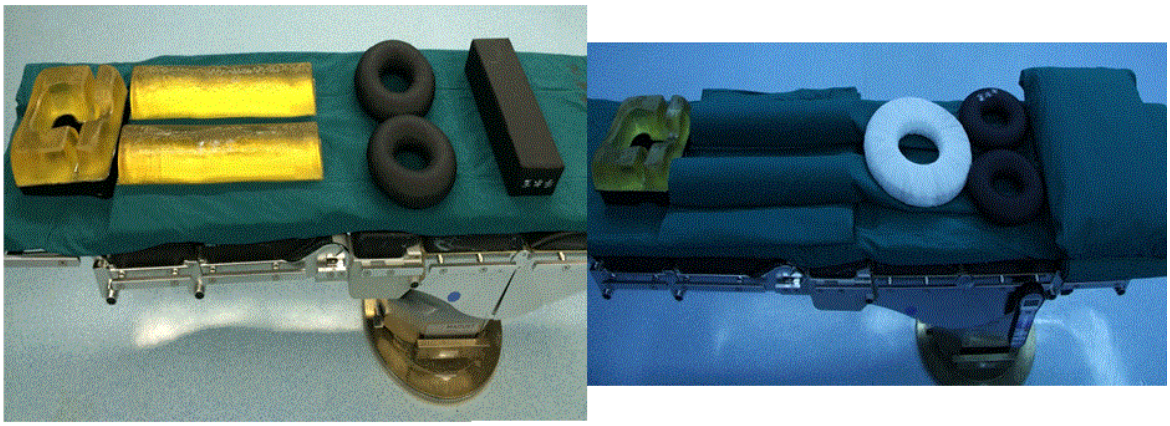

Figure 1C

Figure 1: Setting up prone position placement for optimal position for surgical patients during their pre-surgical visit to surgery room. Soft pads and gels used to set up for prone position (A), and basic setting for a prone condition using different size and shapes of pads and gels (B), and training and setting optimal position for prone placement specifically to individual patient (C).

Results

Patient's health condition - hospital stay time

During the study, a total of 58 males and 72 females with scoliosis were admitted for corrective orthopedic surgery. Table 1 summarizes participant demographics and shows no statistical difference between test and control groups in terms of the average age, gender, body size (body height and weight), and scoliosis type of these patients. The number of days in hospital after surgery is 17.50 ± 7.57 for test group and is 22.18 ± 7.29 for control group, showing a significant difference ($p<0.05$).

Physiological conditions of the surgical patients

Comparative analysis has revealed the significant difference among surgical patients between the test and control groups (Table 2) in terms of their respiration, heart rates, and systolic and diastolic pressures. The significant increase of these values were detected for the control patients at the time upon their entering the surgical rooms but such a big change in respiration and heart rates and systolic and diastolic pressures did not occur to the patients in test group. The increased rates of respiration and heart rate and systolic and diastolic pressures retained till the time of their surgery in control patients compared to patients in test group whose physiological conditions reached to normal conditions (Table 2).

	Respiration (time/min)	Heart rate (time/min)	Systolic pressure (mmHg)	Diastolic pressure (mmHg)
Control group				
T-1	19.11 ± 1.14	81.75 ± 11.60	118.06 ± 10.20	74.75 ± 9.15
T-2	20.95 ± 1.27	89.91 ± 8.31	125.05 ± 14.25	80.06 ± 10.38
T-3	20.43 ± 1.28	87.53 ± 8.89	123.93 ± 10.30	78.95 ± 12.60
Test group				
T-1	19.14 ± 1.43	81.48 ± 14.62	118.22 ± 13.21	74.37 ± 10.85
T-2	19.85 ± 3.12	82.96 ± 10.53	120.59 ± 21.33	75.05 ± 10.72
T-3	19.51 ± 1.88	82.25 ± 10.06	119.23 ± 15.26	75.13 ± 12.52
F	172.95	3.05	1.78	20.15
P value*	P<0.01	P<0.05	P<0.05	P<0.01

Table 2: Comparison of respiratory and circulatory function of patients between test and control groups (± s) repeated measures analysis of variance, T-1 = 3 days prior to surgery; T-2 = the time of patient entered surgical room; T-3 = the time just prior to surgery, *Two groups showed significant difference at the same time point (P<0.05)

Occurrence and degree of pressure ulcers: To determine if the pre-surgical visit contributes to the improved health condition of surgical patients, incidence and degree of PU development were recorded for individual patients upon the completion of surgical operation and compared between the test and control groups. As summarized in Table 3, pressure ulcers occurred in 9 patients (13.8%) in the test group as compared to 22 patients in control group (33.8%), indicating a statistically significant difference (P>0.05) between the two groups. In addition, the pre-surgical visit intervention also reduced the severity of the PU incidence. Among the patients with PU, only two in test group had the PU size larger than 2 cm while in control group, relatively larger size of PU (>2 cm) occurred in majority ones (12/22). Also, more severe cases of pressure ulcers (levels II and III) were observed among patients in the control group.

No.	Characteristics	Test group n (%)	Control group n (%)	Statistic value	P value
1	**PU**				
	Occurrence	9 (13.8)	22 (33.8)	$\chi^2 = 7.16$	P<0.05*
	None	56 (86.2)	43 (66.2)		
2	**PU Size (cm)**				
	<2.0	7 (10.8)	10 (15.38)	$\chi^2 = 0.609$	P>0.05
	2.0-5.0	1 (1.54)	9 (13.85)	$\chi^2 = 6.933$	P<0.05*
	>5.0	1 (1.54)	3 (4.62)	$\chi^2 = 0.258$	P>0.05
3	**PU severity**				
	I	5 (7.69)	14 (21.54)	$\chi^2 = 4.993$	P<0.05*
	II	3 (4.62)	5 (7.69)	$\chi^2 = 0.133$	P>0.05
	III	1 (1.54)	3 (4.62)	$\chi^2 = 0.258$	P>0.05
	IV	0	0		

4	**Preparation time (min)** Mean (sd)	36.91 ± 2.82	47.61 ± 4.36	t = -40.82	P<0.05*
5	**Total surgery time (hour)** Mean (sd)	7.29 ± 1.88	7.42 ± 2.33	t = - 0.27	P>0.05

Table 3: Comparison of the occurrence and severity of pressure ulcers (PU) and surgery time of scoliosis patients between the test and control groups (n = 130), *P<0.05 – two groups showing statistically significant difference.

Preparation and total time in surgery room: A pre-surgical visit to surgical rooms also shortened the time for test group patients on their day in surgical room. As shown in Table 3, the total time for test group patients in surgery room on the day of their surgery averaged 7.29 ± 1.88 hours compared to the total time of 7.42 ± 2.33 for control group patients, showing a difference but not at statistically significant level. However, the surgery preparation time between the two groups is significantly different (p<0.05) showing that the time from patients entering the surgical room to the start of surgical procedure is 36.91 ± 2.82 min for patients in test group while the same process took 47.61 ± 4.36 min for control patients.

Discussion

Pressure ulcers are a serious complication of surgical procedures, which affect as many as 45% of all surgical patients [12]. Scoliosis patients are particularly impacted, as corrective orthopedic surgery requires them to lie in prone position for hours or longer, facing risk factors including anesthesia, improper positioning, and length duration of surgery. Current studies have indicated that patients affected by PU development usually require a longer hospital stay [13] and face an increased risk of mortality [13,14]. Therefore, there has been of increased interest in testing and developing measurements to prevent/reduce PU development for surgical patients [15]. Current approaches are primarily focusing on pressure reduction and relief through the use of soft supporting mats and surface [16]. In particular, customized silicon pads or face pillows, self-made water pad, water cushion, liquid dressing and polyurethane gelatin pads, or the fat first lap are utilized with varied success [9,11,17-19]. A recent report described successful application of water pillows for surgical patients with reduced PU incidence by 50% through creating new pressure reduction support surfaces [20].

PU development among surgical patients can be affected by many health care factors, including during surgery and improper positioning [12,21,22]. The occurrence of PU was reported to be particularly linked with improper prone position since it often places the patients in a compromised condition with increased risk [12,3,24]. Therefore, it is required to take prevention measurements at all aspects within surgical care in order to reduce the possibilities of PU occurrence. In this study, we tested and evaluated an approach aimed at reducing the incidence of PU by setting up the most comfortable prone position for individual patients. This was achieved through arranging patients for a pre-surgical visit to surgical room 3 days prior to their surgery with adaptive prone position training. Findings from this study have demonstrated that this one-time simple visit to surgery room has significantly reduced the PU incidence among test patients and offered beneficial impact to surgery patients in several ways.

At first, since some level of anxiety is to be expected of patients facing an undergoing complicated surgical procedure, the intervention of the pre-surgery visit has effectively increased their comfort of scoliosis patients before and during surgery. Findings from this study has clearly indicated that a simple visit plus cordial conversation and consultation with surgical nurses prior to surgery operation has promoted an enhanced understanding between patients and nurses, and upcoming surgical procedures and environment while also serving to assuage patient fears/anxiety significantly. A recent study has indicated that anxiety and depression can negatively affect surgery and lead to prolonged recovery periods of surgical patients [25,26]. Our finding of significantly reduced hospital time for test group is in agreement with Guo's report [25]. Therefore, the pre-surgical visit can help to create a comfortable surgical environment and less tensed condition of the patients, which is important and helpful not just for a successful completion of surgical operation, but is also known to have more positive effect on post-surgery outcomes [25,26]. In addition, our study further emphasizes the importance of knowing accurate medical information and treatment process for respective patients and medical nurses in order to achieve more effective therapeutics and reduced health risks [27,28].

Secondly, the pre-surgical visit to surgery room has significantly reduced day-of-surgery preparation time for test patients. On the day of their surgery, the time between entering the operating room and the commencement of the surgical procedure is approximately 11 minutes less for test patients than that documented for control patients. The extended preparation time among control group was due to the standard day-of surgery procedure, which includes the introduction and discussion of the procedure, and prone position placement and adjustment following anesthesia [8,21]. On the other hand, the patients in test group can be quickly ready for surgery operation under the preset optimal prone position with less or no question since they knew the procedure and how to work with the nurses. Considering posterior fusion surgery is such a complex and prolonged procedure [8,15,29], any reduction to overall time in surgical room on the day of surgery could lessen the mental and physical exhaustion stress of the patient and surgical staff as well, and also make positive impact to patients on the completion of surgical process and post-surgery recovery [29].

Thirdly, this pre-surgical visit to surgical room allowed patients to designate their personalized optimal prone positioning. Under the standard day-of-surgery process, patients lying in supine position were rolled into prone position under anesthetized condition for position adjustment just before their surgery [15,20]. Thus, the position set up by surgical nurses may not be optimal or may even be improper to individuals since standard method does not allow the patient to fully communicate any discomfort with the nurse [11,21]. As comparison, the pre-surgical visit approach applied in this study enables the patient to effectively communicate with the nurse and designate their own optimal positioning because this was done 3 days prior to their surgery when anesthesia was not applied. Thus, the established comfortable prone position allows to reduce any possibility of obstructed breathing, excess pressure on sensitive skin, and overall discomfort of patients [11]. The data obtained from this study has demonstrated that the

implementation of one-time pre-surgical visit to surgical room has led to a significant reduction in incidence and severity of pressure ulcers to the patients of test group who selected their own positioning as compared to control patients.

A possible limitation to this pre-surgical visit intervention is the lack of time or space within hospital operating rooms (ORs). Frequently, operating rooms might be completely reserved so that making time for pre-surgical visit interventions within the OR may prove difficult. However, this limitation can be remedied if a spare, non-functional room is available. Medical staff can configure the room to resemble a functioning OR to mimic the same environment the patient will experience on the day of their surgery. A spare surgical bed with support pads can be utilized for optimal prone position placement and the designated pad positioning can be represented for the patient in the functional OR during their surgical procedure. More evidence-based research in this area will encourage practice changes that will in turn help decrease PU development, improve patient comfort, decrease patient mortality, and lower health care costs

Conclusion

Current approaches for the prevention of scoliosis surgery caused PU incidence are largely focused on the use of different supporting materials to reduce the excessive and prolonged pressure of surgical patients. This study demonstrated a pre-surgical visit to surgery room to be a simple but effective intervention approach to reduce and prevent the incidence of PU development. The adaptive training through the pre-surgery visit provided the surgery patients not just the best prone position for their surgery, but also most comfort conditions for their surgery including less stress, anxiety, and fears. Since this intervention approach is technically simple and effective, it could be readily applicable to other surgery operating rooms for the purpose of preventing PU occurrence and other surgical related health damage due to improper positioning and physiological condition of surgical patients. Therefore, findings from this study warrantee more in-depth more through study with large enrollment of scoliosis patients at different hospital sites to fully establish the conditions for enhanced health care and lessened incidence of pressure sore of scoliosis surgery patients.

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