

## ORIGINAL ARTICLE

# Comparison of platelet-rich plasma gel in the care of the pressure ulcers with the dressing with serum physiology in terms of healing process and dressing costs

Özge Uçar  | Sevim Çelik

Department of Nursing, Faculty of Health Sciences, Bartın University, Bartın, Turkey

**Correspondence**

Özge Uçar, Department of Nursing, Faculty of Health Science, Bartın University, Merkez, Bartın, Turkey.  
Email: ozgecan3112@hotmail.com

**Funding information**

Zonguldak Bulent Ecevit University Scientific Research Projects Unit, Grant/Award Number: 2018-19093093-01

**Abstract**

This research was carried out with the aim of comparing the effects of platelet-rich plasma (PRP) gel and gas dressing with serum physiologic applied to stage II pressure ulcer in coccyx of patients for 2 months on healing process and dressing costs. This prospective randomised controlled experimental study was conducted with 60 patients hospitalised in the palliative care unit after surgery. The experimental group ( $n = 30$ ) was dressed with platelet-rich plasma gel. The control group ( $n = 30$ ) was treated with serum physiologic dressing. At the end of the 20th observation of the patients in the experimental group, it was found that the mean scores of area, exudate, and tissue type in pressure sores decreased statistically ( $P < .001$ ). In the control group, no significant difference was found between the mean PUSH score at the end of the 20th observation ( $P > .05$ ). The study showed that PRP gel had a positive effect on healing of stage II pressure ulcers with platelet-rich plasma gel dressings. In addition, when evaluated in the long term, it was concluded that platelet-rich plasma gel is easily accessible and less costly than serum physiological dressing.

**KEYWORDS**

platelet-rich plasma, pressure injury, pressure ulcer, serum physiological dressing, skilled nursing facilities

## 1 | INTRODUCTION

Pressure ulcers is the situation of having damage on the skin and subcutaneous tissues due to prolonged or repetitive pressures, especially in areas where the body has bone protrusions.<sup>1,2</sup> Pressure ulcer is an important health problem that causes serious pain and discomfort in patients, prolonged hospital stay, long and complex treatment and care practices, increased health care costs, decreased life quality, and increased mortality rate.<sup>1-3</sup> Although the aetiology, pathology, prevention, early diagnosis, and treatment methods are well known, this problem remains serious in clinical and surgical terms.<sup>4</sup>

According to the data published by the National Pressure Ulcer Panel (NPUAP) in 2016, the incidence of pressure ulcers in U.S.A. varies between 1.3 and 3 million. The annual cost of pressure sores was found to be between 2.2 and 3.6 billion dollars.<sup>5</sup> In Europe, the frequency of pressure ulcers has increased from 8.3% to 25.1%.<sup>3</sup> In Turkey, in a survey conducted on 569 patients by Genç and Ozkan, 15% of patients with the formation of pressure ulcers in the first day of hospitalisation and 2% of patients with pressure ulcers between 10 days and 59 about was reported.<sup>6</sup> In addition, in research conducted in intensive care units in Turkey, it was found that most of the pressure ulcers are on sacrum area (60%) and in II stage (40%).<sup>7</sup>

Prevention of pressure ulcer is one of the most important quality indicators of healthcare services. Moreover, it is noteworthy that the frequency of pressure ulcers is still high in patients. Nonpreventable pressure ulcers by causing complications such as infection leads to an increase in the mortality rate and affect patient outcomes adversely.<sup>8,9</sup> A variety of methods is available to provide pressure ulcer healing involving a dynamic and complex process. Of these, the most widely used and the lowest cost is considered to be gas dressing with serum physiologic (SP).<sup>10,11</sup> Serum physiological gas dressing is a method that prevents the entry of external microorganisms into the wound that protects the moisture of the wound. However, it cannot provide sufficient antiseptic properties in the wound.<sup>10,11</sup>

In recent years, platelet-rich plasma (PRP) gel derived from the patient's own blood used frequently in acute and chronic wounds has been known. Cytokines, growth factors, chemokines, and fibrin in PRP gel have been shown in results of the studies to stimulate angiogenesis by interacting with fibroblasts, promoting collagen fibre production, and increasing the migration of keratinocytes. In the same research results, it was emphasised that the effects of PRP gel accelerated the healing time of wounds and shortened the length of hospital stay, decreased the cost of care, and minimised the risk of infection.<sup>12-14</sup> In addition, growth factors and PRP gel obtained from the individual's own blood have been reported to minimise the risk of allergic reaction and disease transmission in the individual.<sup>13</sup> Decrease in treatment and care costs and decrease in time and energy spent by health professionals for patient care have been effective in increasing interest in PRP and spreading its use.<sup>13,14</sup>

This research was carried out with the aim of comparing the effects of platelet rich plasma (PRP) gel and gas dressing with serum physiologic applied to stage II pressure ulcer in coccyx of patients for 2 months on healing process and dressing costs. For this purpose; "H1: PRP gel dressing with pressure ulcer healing process results are more positive than SP dressing," "H1: The cost of dressing with PRP gel is lower than SP dressing" hypotheses were tested.

## 2 | METHOD

### 2.1 | Design and participants

The universe of this randomised controlled experimental study was determined in a state hospital between January 1, 2017 and December 31, 2017 by 60 patients with coccyx pressure ulcer. Patients who are 18 years

### Key Messages

- serum physiological dressing is not effective on healing of pressure ulcer and it increases length and width of ulcer
- platelet-rich plasma gel dressing heals and accelerates pressure ulcers effectively
- platelet-rich plasma gel is easily accessible and cost effective than physiological gas dressing

old or older with normal signs of renal function, albumin, platelets, blood glucose, whose normal mobility is semi or fully limited, with Turkish literacy, who presented to the palliative department due to surgical intervention and who have coccyx stage II pressure ulcer with no immunodeficiency diagnosis were included to the study. We aim to access the universe for the study. All patients who met the research criteria between January 1, 2018 and December 31, 2018 formed the sample group (n = 62). Two patients were excluded from the sampling after their preference of not attending the study. Therefore, the research was performed with 60 patients. The patients were divided into two groups as experimental group (dressing with PRP gel) and control group (gas dressing with routine SP) with randomization process ([www.randomizer.org](http://www.randomizer.org)). Patients were placed in a 1: 1 ratio (Figure 1).

### 2.2 | Data collection tools

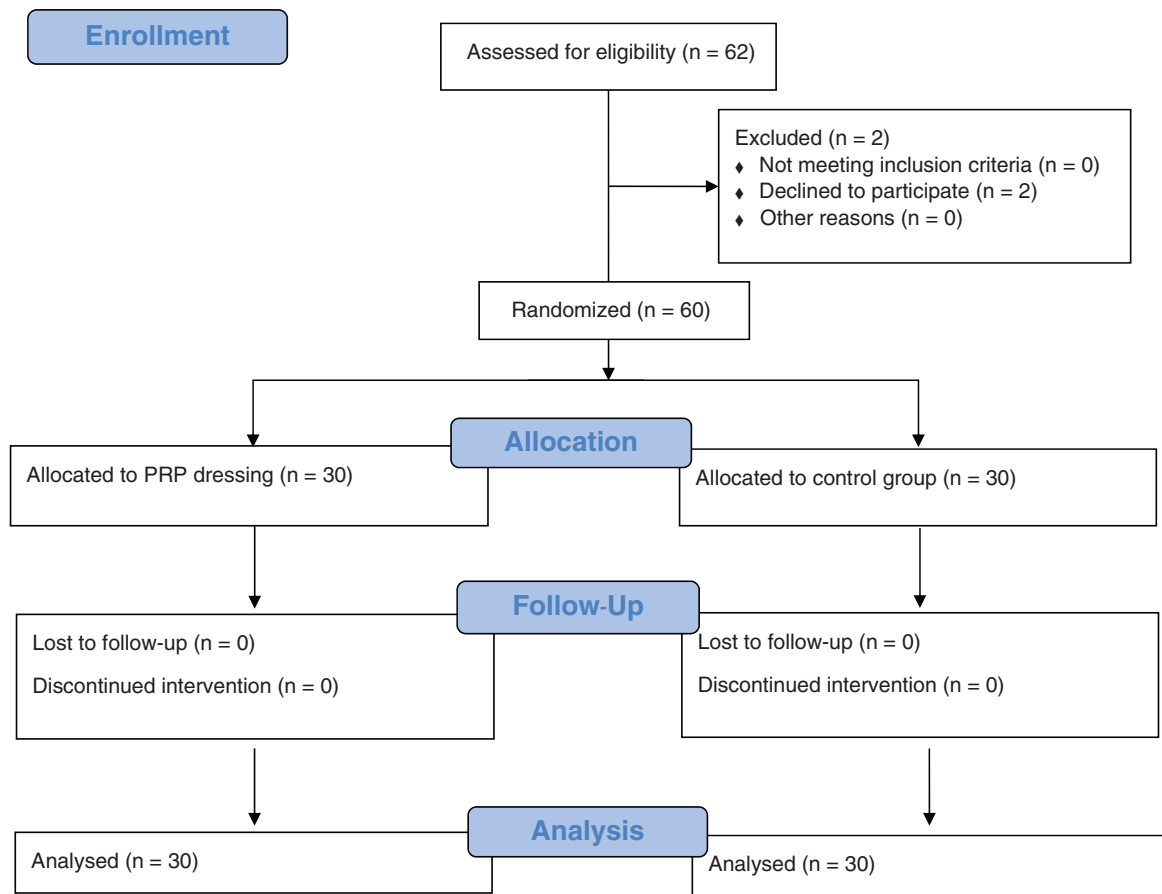
Data were collected using the survey form, the Barthel Daily Living Activities Scale, Glaskow Coma Scale, and Pressure Ulcer Scale for Healing (PUSH).

### 2.3 | Survey form

This form consists of three parts: the demographic and clinical characteristics of the patients, the scales to be used in the study, and the schedule of the materials used during the dressings.

*First part;* consists of age, sex, smoking habit, duration of hospitalisation, duration of surgery, anaesthesia used in surgery, steroid use, independent mobilisation status, height, weight, body mass index (BMI), accompanying diseases, blood values of the patient, and demographic data including life findings.

*Second part;* consists of the Glaskow Coma Scale, which assesses the level of consciousness of the patients,



**FIGURE 1** The CONSORT flow diagram of patients in the prp and control groups

and the Barthel Daily Living Activity Scale, which reflects the state of activity, consist of PUSH to assess the healing of the pressure ulcer.

In the third section, for the purpose of the research dressing types of materials used during the maximum 20 dressings are recorded in the table.

## 2.4 | The Barthel Daily Living Activity Scale

This scale, which is used to determine the independence status of the individual's activities in daily life, consists of 10 items. They are stool continence, urine continence, nutrition, daily care (facial washing, hair care, and shaving), dressing, transfer, toilet use, mobility, step up, and bathroom. Each item is evaluated (unaided, assisted, unable to do, etc.) and the patient gets a score between 0 and 15. The total score of the items ranged from 0 to 100. The decrease in the value of the score indicates that the patient is dependent. In this index, 0 to 20 points are completely dependent, 21 to 60 points are highly dependent, 61 to 90 points are moderately dependent, 91 to

99 points are mildly dependent, and 100 points explain independence.<sup>15,16</sup> The Turkish validity and reliability study of the Barthel Daily Activities Index was published by Küçükdeveci et al in 2000. In this study, the Cronbach's alpha value of the scale was calculated to be 0.93 for stroke patients and 0.88 for patients with spinal cord injury.<sup>16,17</sup> In this current study, the reliability and validity coefficient was found to be 0.95.

## 2.5 | Glaskow Coma Scale

The Glaskow Coma Scale, created in 1974 by Teasdale and Jennett is examined in three categories as eye opening, verbal, and motor response. Eye opening is scored as 1 to 4 points, verbal answer is scored as 1 to 5 points, and motor response is scored as 1 to 6 points. The total score is between 3 and 15 points. Patients between 13 and 15 points are completely awake and have good orientation. Patients with a score of 8 to 12 are considered as having problems in alertness and orientation and decreased consciousness level. Patients with coma are those with a score of 7 or less.<sup>18,19</sup>

## 2.6 | Pressure Ulcer Scale for Healing

PUSH, commonly used to monitor and evaluate changes in the state of pressure ulcers, was developed by NPUAP. The scale consists of three subcategories: area of pressure wound, amount of exudate, and tissue type.

The area of the pressure ulcer is calculated in  $\text{cm}^2$  by multiplying the length and width of the ulcer. The calculated area is evaluated on a scale of 10 points. After the dressing is removed, the amount of exudate is evaluated within the range of 0 to 3 points observing with the diameter of the wound before a new dressing is performed. Finally, while the ulcer healing is observed, the tissue type in the ulcer bed is evaluated by giving a score between 0 and 4 points. When scoring the tissue type; 4 points for necrotic tissue, 3 points for crusting, 2 points for granulation tissue, 1 point for epithelialization, 0 points for ulcer closed. The lowest score that can be obtained from this scale is 0 and the highest score is 17. It is interpreted that the higher the score, the larger the ulcer and the greater the severity of the condition. International studies have shown that this scale has validity and reliability. According to Gardner et al's study on 32 pressure sores in 2005, the healing of ulcers was parallel to the PUSH scale by 66%.<sup>20</sup> However, a validity and reliability study of the PUSH scale, which is frequently used in our country, has not been found.<sup>21</sup> In this study, PUSH Cronbach Alpha value was found to be 0.99.

## 2.7 | Information about technical equipment

In this research, centrifuge was used to obtain autologous PRP gel. The device used is a desktop type and consists of eight rotors. The rotors in the device consist of buckets having fixed angle or opening shape. It can be used by placing 1.4 to 15 ml blood tubes in buckets. This device can be used for platelet-rich plasma, platelet-poor plasma, urine analysis, clinical chemistry analysis, haematology analysis, serum preparation with gel tubes, and cell culture pelleting. A cell phone camera with a camera definition of 12 MP + 12 was used for the assessment of pressure sores. This camera has been chosen for its true-life colour (True Tone), lightness, and ease of transport and ease of transfer.

## 3 | PROCEDURE

### 3.1 | Ulcer assessment

Firstly, the parameters in the first and second parts of the survey form were obtained from patients and patient files

to determine the conditions that might affect the healing of pressure ulcer. According to pressure ulcer treatment and maintenance procedures, ulcer depth, surface area, and tissue type were used as criteria for wound healing. After the pressure wounds were evaluated by the researcher, the wounds with necrotic tissue were debrided by a specialist plastic surgeon before dressing. The debrided ulcers were reobserved and visualised with a mobile phone camera before the maintenance. All pictures were taken at a distance of 30 cm before patients were treated. Pressure ulcers were measured with a disposable wound ruler before maintenance. The state of the pressure wound was calculated by PUSH and recorded in the survey form.

### 3.2 | The preparation of PRP gel

There is no specific protocol in the literature for the preparation of PRP gel.<sup>22,23</sup> Firstly, blood tests were performed in order to determine whether the patients had anaemia or similar conditions. Then, 10 cc blood was taken from the patients with sterile syringe and mixed with 3 cc sodium citrate blood tubes to prevent the blood from collapsing. Subsequently, the PRP gel was centrifuged at 2000 rpm for 5 minutes in a tabletop centrifuge without waiting.<sup>22</sup> The room temperature in the treated environment was measured with a digital thermometer and the temperature was constant ( $22^{\circ}\text{C}$ - $24^{\circ}\text{C}$ ) in order to avoid any temperature difference. Then, the prepared PRP gel was separated from the tube with sterile forceps and placed on sterile gauze. The wound, which was washed and cleaned with physiological saline, was covered with sterile gauze impregnated with PRP gel and fixed with cotton tapes.

### 3.3 | Dressing application

After the first measurements, pressure ulcers were washed and cleaned with serum physiologic in the control group. Wound debridement was performed before dressing if it was necessary. The ulcers were closed with sterile gauze and fixed with cotton tapes and the pressure ulcer was repeated daily. In the experimental group, after washing with serum physiologic, the pressure wound was covered with sterile gauze impregnated with PRP gel and fixed with cotton bands. The treatment with PRP gel was repeated once every 3 days. Ulcer measurements were performed in both groups every 3 days. After the dressings were completed, the amount of material used was recorded on the survey form. This treatment lasted 2 months in both groups and 20 patients were observed. If dressings were contaminated with faeces or urinary incontinence, the dressing was renewed. All dressings

**TABLE 1** Demographic, laboratory, and clinical characteristics of patients in platelet-rich plasma and serum physiological groups

Characteristics	PRP gel dressing		SP gas dressing		$\chi^2$	$P^a$
	Number	Percent (%)	Number	Percent (%)		
Gender					0.073	.787
Female	10	47.6	11	52.4		
Male	20	51.3	19	48.7		
Smoking					0.405	0.579
Yes	11	57.9	8	42.1		
No	19	46.3	22	53.7		
Anaesthesia					0.194	0.299
General	11	36.7	16	53.3		
Spinal	19	63.3	14	46.7		
Steroid use					0.190	0.295
Yes	20	66.7	15	50.0		
No	10	33.3	15	50.0		
Mobilisation					0.741	0.671
Dependent	28	93.3	26	86.7		
Independent	2	6.7	4	13.3		
Existing diseases						
Musculoskeletal	9	30.0	10	33.3	0.077	0.781
Circulatory system	24	80.0	28	93.3	0.129	0.254
Obesity	10	33.3	9	30.0	0.077	0.781
Endocrine system	2	6.7	3	10.0	0.218	0.640
Allergy	3	10.0	4	13.3	0.162	0.688
Cirrhosis	3	10.0	2	6.7	0.218	0.640
Urinary system	3	10.0	4	13.3	0.162	0.688
Respiratory system	14	46.7	14	46.7	0.000	1.000
Depression	9	30.0	5	16.7	0.222	0.360
Characteristics	PRP gel dressing $X \pm SD$		SP gas dressing $X \pm SD$		$Z$	$P^b$
Age	68.30 $\pm$ 6.37		67.80 $\pm$ 5.86		-0.052	.959
Body Mass Index	25.83 $\pm$ 0.99		25.87 $\pm$ 1.04		-0.171	.864
Total protein (g/dl)	5.58 $\pm$ 0.77		5.67 $\pm$ 0.84		-0.504	.614
Albumin (g/dl)	2.6 $\pm$ 0.34		2.72 $\pm$ 0.43		-0.468	.640
Haemoglobin (g/dl)	10.51 $\pm$ 1.78		10.26 $\pm$ 1.74		-0.334	.738
Platelets	357.27 $\pm$ 85.49		298.63 $\pm$ 121.61		-2277	.023
Blood glucose level (mg/dl)	96.93 $\pm$ 11.18		109.23 $\pm$ 23.02		-2708	.007
Urea (mg/dl)	58.97 $\pm$ 50.47		66.07 $\pm$ 55.77		-0.636	.525
Uric acid (mg/dl)	3.20 $\pm$ 1.42		4.12 $\pm$ 2.10		-1517	.129
Sodium (mEq/L)	137.07 $\pm$ 5.72		138.30 $\pm$ 7.00			.458
Potassium (mEq/L)	4.07 $\pm$ 0.58		4.10 $\pm$ 0.91		-0.482	.630
Chlorine (mmol/L)	97.82 $\pm$ 8.17		98.47 $\pm$ 8.27		-0.325	.745
Calcium (mg/dl)	8.40 $\pm$ 0.80		8.81 $\pm$ 1.16		-1.37	.171
Systolic blood pressure(mmHg)	113.33 $\pm$ 9.22		112.33 $\pm$ 11.35		-0.504	.614

(Continues)

TABLE 1 (Continued)

Characteristics	PRP gel dressing $\bar{X} \pm SD$	SP gas dressing $\bar{X} \pm SD$	Z	P <sup>b</sup>
Diastolic blood pressure (mmHg)	68.67 ± 6.81	67.00 ± 7.50	-1001	.317
Oxygen saturation(%)	94.43 ± 2.30	93.93 ± 2.65	-0.728	.467
Body temperature(°C)	36.66 ± 0.32	36.64 ± 0.32	-0.157	.875
Heart rate (beats/min)	93.87 ± 9.12	90.67 ± 13.54	-0.963	.335
Capillary refill time (s)	5.13 ± 0.97	5.30 ± 1.18	-0.376	.707
Barthel scale	25.18 ± 2.56	25.13 ± 2.32	-1.378	.846
Norton scale	8.12 ± 1.63	8.2 ± 2.01	-0.678	.623

<sup>a</sup>Chi-square test was used.

<sup>b</sup>Mann Whitney U test was used.

PUSH	Dressing group		Z	P <sup>a</sup>
	PRP gel dressing $\bar{X} \pm SD$	SP gas dressing $\bar{X} \pm SD$		
Total score	8.43 ± 2.34	9.53 ± 2.21	-1573	.116
Length × width (in cm <sup>2</sup> )	4.70 ± 1.78	4.83 ± 1.34	-0.475	.635
Exudate amount	1.93 ± 0.74	2.17 ± 0.70	-1127	.260
Tissue type	1.87 ± 0.43	1.87 ± 0.43	0.001	.999

<sup>a</sup>Wilcoxon test was used.

TABLE 2 Comparison of PUSH score means of serum physiological gas dressing and platelet rich plasma gel at first observation



FIGURE 2 Condition of the pressure ulcer gas dressing with SP at 1st observation and 20th observation

were performed by the researcher in order to avoid any differences between the treatments. No different application or medical wound dressing support was used.

### 3.4 | Ethical approach

Written permission was obtained from Zonguldak Bulent Ecevit University Clinical Research Ethics Committee

(decision dated January 31, 2018 and numbered 2018/35-31/01) from the provincial health directorate (23/08/2018-39 330677-799). Palliative service physicians and nurses were also informed about the study and verbal approvals were obtained. According to the consciousness of the patients included in the scope of the study, the patient or his / her first-degree patient's relatives were informed about the study and their informed consent was obtained. Within the scope of the research, the consent of the participants was obtained that the pressure sores would be displayed without prejudice to their identity information. The participants were informed that they could leave the research if they wanted. Patients were informed that the photos would be published for scientific purposes and their permission was obtained.

### 3.5 | Data analysis

The data obtained in this study were analysed with the SPSS 15 package program. Kolmogorov-Smirnov test was used to determine the normal distribution of variables. When the differences between the groups were examined, *t*-test was used for independent variables when the variables were compatible with the normal distribution.

**TABLE 3** Comparison of PUSH score means of platelet rich plasma gel and serum physiological gas dressing

PUSH	Observations	Dressing group		Z	P <sup>a</sup>
		PRP gel dressing X ± SD	SP gas dressing X ± SD		
Total score	1st observation	8.43 ± 2.34	9.53 ± 2.21	-1573	.116
	20th observation	5.00 ± 3.97	9.37 ± 2.39	-4079	.001
Z P		Z = -4572 P = .001	Z = -0.148 P = .883		
Length × width (in cm <sup>2</sup> )	1st observation	4.70 ± 1.78	4.83 ± 1.34	-0.475	.635
	20th observation	2.83 ± 2.42	5.00 ± 1.31	-3454	.001
Z P		Z = -4504 P = .001	Z = -1387 P = .166		
Exudate amount	1st observation	1.93 ± 0.74	2.17 ± 0.70	-1127	.260
	20th observation	0.93 ± 0.87	1.93 ± 0.74	-4057	.001
Z p		Z = -4278 P = .001	Z = -1578 P = .115		
Tissue type	1st observation	1.87 ± 0.43	1.87 ± 0.43	0.001	.999
	20th observation	1.20 ± 0.96	1.97 ± 0.61	-3314	.001
Z p		Z = -3386 P = .001	Z = -0.905 P = .366		

<sup>a</sup>Mann Whitney *U* test was used.

Nonparametric Mann Whitney *U* test was used in cases where the variables were not compatible with normal distribution. Nonparametric Wilcoxon Test was used when the differences between the two dependent variables were not consistent with the normal distribution. Chi-Square and Fisher's Exact Test were used to examine the relationships between the groups of nominal variables. 0.05 was used as the level of significance.

#### 4 | FINDINGS

Each of the 60 patients included in the study was followed for 2 months. Patients did not experience any loss. There was no statistically significant difference between the blood glucose level and all the demographic and clinical characteristics of the patients in the experimental and control groups included in the study, and the groups were homogeneous ( $P > .05$ ). Although platelet and blood glucose levels of the patients showed statistically significant differences ( $P < .05$ ), it was found that the measured values were within normal clinical limits (Table 1). When the initial observation results of the pressure wound were evaluated using PUSH, it was found that there was no statistically significant difference between the pressure ulcers of the patients in the experimental and control groups, and the groups were homogeneous ( $P > .05$ ) (Table 2).

In the study, no statistically significant difference was found between the mean PUSH scores in the pressure ulcer in the control group with SP dressing after the first



**FIGURE 3** Condition of the pressure ulcer PRP gel dressing at 1st observation and 20th observation

dressing (1st observation) (Figure 1) and at the end of the second month (20th observation) ( $P > .05$ ) (Figure 2). In the 20th observation of gas dressing performed with SP, it was found that mean PUSH area and tissue type scores increased and exudate decreased (Table 3) (Figure 2). In the PRP gel dressing, there was a statistically significant difference between the mean PUSH scores at the first observation and at the end of the second month ( $P < .001$ ) (Figure 3). In the same table, in the 20th observation of the dressing performed with PRP gel, it was found that the mean scores of the pressure wound area, exudate, and tissue type decreased significantly ( $P < .001$ ) (Table 3) (Figure 3).

**TABLE 4** Amount and cost of material used in dressings

Material	Unit price (TL) <sup>a</sup>	PRP gel dressing		SP gas dressing	
		Amount (piece)	Total price (TL) <sup>a</sup>	Amount (piece)	Total price (TL) <sup>a</sup>
Injector (10 cc)	0.23	1200	276	1800	414
Disposable gloves	0.14	2400	336	3600	504
Blood tube	0.75	1200	900	0	0
Sterile gauze	0.14	1200	168	5760	806.40
Cotton band	2.00	1.65	3.30	9.55	19.10
Serum physiological (100 cc)	2.86	600	1716	1800	5148
Cotton (1 kg)	13.00	1	13	0	0
Alcohol (1 L)	40.00	1	40	0	0
Centrifuge device	6.01800	1	6.01800	0	0
Total			9.37030		6.89150

<sup>a</sup>It was determined in accordance with the quotations received.

When the results of the 20th observation of the experimental and control groups were compared, it was determined that PUSH total area, tissue type, and exudate mean scores of the patients in the experimental group decreased significantly and a healing was realised. ( $P < .001$ ).

The consumables used for dressing with SP and their cost are shown in Table 4. According to this, at the end of 2 months, the cost of dressing with SP was found to be 6.891.5 TL and the cost of dressing with PRP gel was 3.352.3 TL (Table 4). Centrifugal device was used for dressing with PRP gel but the centrifugal device has bought just one time for hospital. The total cost was calculated as 9.370 TL with this 6.018 TL centrifuge.

## 5 | DISCUSSION

The risk of developing pressure ulcers increases in patients who have undergone surgical procedures due to the type of surgery, decreased mobility, and prolonged hospital stay. Pressure ulcers lead to secondary infection in these patients and prolong the hospitalisation period and increase the cost of treatment. In this respect, the type and quality of care for pressure ulcers is of great importance.<sup>2,24</sup>

When the literature on pressure ulcer healing is examined, it is seen that the most commonly used method for the maintenance of pressure wound is gas dressing with SP and many research studies have been carried out about this method.<sup>25,26</sup> On the other hand, the number of studies performed with PRP is not sufficient, and in this small number of studies, it has been reported that PRP gel accelerates the healing of pressure

wounds and surgical wounds.<sup>27,28</sup> Although there is no research on this subject in our country, the insufficiency of the sample number and the lack of empirical research studies in the world have attracted attention.

In this experimental study using PUSH, it was found that the mean PUSH score decreased significantly in the pressure sores with PRP gel dressing after 20th observation ( $P < .05$ ). In addition, it was found that PUSH total score averages increased after 20th observation of gas dressing with SP. Hon et al observed diabetic wounds, pressure wounds, and venous wounds and reported that the PUSH scale is a valid measurement tool in measuring wounds.<sup>29</sup>

In this study, it was found that there was no significant difference between the first observation and the last observation in the control group in terms of means PUSH score evaluating ulcer healing ( $P > .05$ ). This finding reflects that SP dressing has no positive effect on wound healing. In a systematic review of two experimental studies by Moore and Cowman, no significant improvement was observed in the pressure ulcer dressing results with SP.<sup>30</sup> Payne et al also compared SP with gas dressing and dressing with modern foams in pressure ulcers, and reported that there was no significant difference in healing in both types.<sup>31</sup> Griffiths et al emphasised that there is no difference between SP and drinking water in terms of ulcer healing and protection.<sup>32</sup> The findings of this research and previous years are in parallel.

In the current study, a statistically significant difference was found between the 1st and 20th observation in the wounds of the experimental group ( $P < .001$ ). This finding shows that in stage II pressure ulcers, dressing with PRP gel heals pressure ulcers in a short time. This finding is also in line with the results of previous



research. Torrecillas et al reported positive pressure healing as a result of pressure ulcer dressings performed with PRP every 3 days for 8 weeks.<sup>33</sup> Likewise, Tendas et al reported improvement in ulcers following PRP application to pressure ulcers nine times during 4 months.<sup>34</sup> Raslan et al applied PRP to chronic wounds in 24 patients, including pressure ulcers, and reported a significant improvement.<sup>35</sup> In a study conducted by Kakudo et al it was seen that there is a complete healing in the chronic ulcers including pressure ulcers after dressing with PRP gel.

In this study, a statistically significant improvement in tissue type was observed with the reduction of exudate area and decrease in the amount of exudate and increase in epithelization ( $P < .001$ ). However, the pressure ulcer did not heal as a result of SP dressings. Moreover, an increase in area size, worsening of tissue healing and decrease in exudate amount were determined. Singh et al performed an experimental study in 2014 with 25 patients and applied SP and PRP to pressure sores.<sup>36</sup> In this study, it was reported that ulcer healing was faster in patients with PRP dressing than patients with SP dressing.<sup>36</sup> In a study conducted by Mazzukko, it was found that almost all of the chronic ulcers healed after PRP gel wound care compared to ulcer care with SP.<sup>37</sup> Anitua et al reported that 72.94% of pressure ulcers were healed in the PRP experimental group and 21.48% in the control group treated with conventional methods ( $P < .05$ ).<sup>38</sup> Rappl found 53.81% healing in PRP application for 20 weeks in 20 patients who developed pressure ulcers due to spinal cord injury.<sup>39</sup> In a study conducted by Sell et al on three patients' pressure sores, it was reported that the vascular structure of wounds and granulation tissue formation accelerated after PRP application.<sup>40</sup> It is seen that the findings obtained from this current study are in line with all the studies conducted at different times in previous years. According to these findings; "H1: PRP gel dressing and pressure wound healing process results are more positive than SP dressing." hypothesis was confirmed.

It is known that pressure ulcers prolong hospital duration and increase costs.<sup>41</sup> The high treatment burden and the prolongation of the healing process are among the most important factors that increase the cost. In this study, it was found that the cost of consumables used in the PRP gel dressing group was lower than the cost of consumables used in the SP and gas dressing group. The cost of the centrifuge and the cost of the dressing with PRP gel was 9.352.3 TL and the cost of the SP dressing group was 6.891.5 TL. However, considering that the centrifuge device is taken to the hospital once, it is noteworthy that the total annual cost of dressing alone will be lower in the group dressed with PRP gel. Moreover, given that the wound healing is accelerated with PRP gel, it

cannot be denied that other treatment and care costs will decrease and the workload of health professionals will decrease in parallel with the shortening of hospitalisation period of the patient.

According to the results of Dougherty's application of PRP gel in non-healing diabetic wounds, it was emphasised that PRP gel improves the quality of life and when it calculates the 5-year cost, it is the lowest costing method compared to other types of care.<sup>42</sup> In the study of El-Nagar comparing PRP with negative pressure ulcer therapy in wound care; it was stated that both methods had the same effect on ulcer healing; however, PRP was a less costly and more easily applicable method.<sup>43</sup> In his study, Shaheen argued that classical methods were insufficient in non-healing wounds, and that maintenance with PRP was easy, effective, and cost-effective.<sup>44</sup> In a study conducted by Cobos et al in diabetic foot ulcers in 2015, it was reported that the PRP method was less costly and more effective.<sup>45</sup> In the results of Torrecillas et al study on a single long-term non-healing pressure wound, it was noted that PRP gel heals the wound and its cost is lower.<sup>33</sup> In line with these data, the results of the current research and the previous research are in line with the hypothesis that the cost of dressing with H1: PRP gel is lower than the gas dressing with SP.

In line with these results, expanding the use of platelet-rich plasma gel in patients with stage II pressure ulcers, evaluating the effects of dressing using traditional dressing with SP and gas dressing using PRP gel, the effects of allergic reaction on pressure ulcers, and the effects of pain on satisfaction of nurses and patients, investigating the effect of platelet-rich plasma gel on treatment and maintenance costs, carrying out future research in a larger sample group and carrying out future research investigating the effect of PRP gel on the healing duration of pressure ulcers with patients in different stages may be proposed.

## ACKNOWLEDGEMENTS

This study was funded by a grant from the Zonguldak Bulent Ecevit University Scientific Research Projects Unit (Grant No: 2018-19 093 093-01). The authors would like to thank the palliative service nurses, M.D. Elif Bozkurt at Zonguldak Atatürk State Hospital, Turkey and we would like to thank Zonguldak Bulent Ecevit University Scientific Research Projects Unit for supports.

## CONFLICT OF INTEREST

The authors declare no conflicts of interest.

## ORCID

Özge Uçar  <https://orcid.org/0000-0002-5710-5394>

## REFERENCES

- Smith S, Snyder A, McMahon L, Petersen L, Meddings J. Success in hospital-acquired pressure ulcer prevention: a tale in two data sets. *Health Affairs*. 2018;37(11):1787-1796.
- Chicosz SL, Voelsang AB, Tarnow L, Hasenkam JM, Fleishcer J. Prediction of in-hospital pressure ulcer development. *Adv Wound Care*. 2019;8(1):1-6.
- Sving E, Idvall E, Högberg H, Gunningberg L. Factors contributing to evidence-based pressure ulcer prevention. A cross-sectional study. *Int J Nurs Stud*. 2014;51:717-725.
- Keelaghan E, Margolis D, Zhan M, Baumgarten M. Prevalence of pressure ulcers on hospital admission among nursing home residents transferred to the hospital. *Wound Repair Regen*. 2008;16(3):331-336.
- National Pressure Ulcer Advisory Panel (NPUAP). NEW 2014 prevention and treatment of pressure ulcers: clinical practice guideline. <http://www.npuap.org/resources/educationaland-clinical-resources/prevention-and-treatment-of-pressure-ulcers-clinical-practice-guideline>. Accessed November 12, 2019.
- Gencer ZE, Ünal E, Özkan Ö. Basınç ülserleri tedavi maliyetleri etkililik analizi; konvansiyonel ve modern yara bakım tedavisi maliyetlerinin karşılaştırılması. *Akdeniz Tıp Dergisi*. 2019;5(2):201-208.
- Igarashi A, Yamamoto-Mitani N, Gushiken Y, Takai Y, Tanaka M, Okamoto Y. Prevalence and incidence of pressure ulcers in Japanese long-term-care hospitals. *Arch Gerontol Geriatr*. 2013;56(1):220-226.
- Kwok A, Simpson A, Willcokson J, Donato D, Goodwin I, Agarwal J. Complications and their associations following the surgical repair of pressure ulcers. *Am J Surg*. 2018;216(6):1177-1181.
- Becmann D, Defloor T, Schoonhoven L, Vanderwee K. Knowledge and attitudes of nurses on PressureUlcer prevention: a cross-sectional multicenter study in Belgian hospitals. *Worldviews Evid Based Nurs*. 2011;3:166-176.
- Dhivya S, Padma VV, Santhini E. Wound dressing. *BioMedicine*. 2015;5(4):24-28. <http://biomedicine.cmu.edu.tw/> Accessed November 27, 2019.
- Laurie S. Wound dressing selection: types and usage 2011; <http://www.woundsources.com/blog/wound-dressing-selectiontypes-and-usage>. Accessed November 27, 2019.
- Martinez-Zapata MJ, Marti-Carvajal AJ, Solà I, et al. Autologous platelet-rich plasma for treating chronic wounds. *Cochrane Database Syst Rev*. 2016;2016(5):1-57.
- Volakakis E, Papadakis M, Manios A, Ioannou CV, Zoras O, de Bree E. Wound healing and antimicrobial effects of chitosan-hydrogel/honey compounds in a rat full-thickness wound model. *Wounds*. 2019;31(10):252-256.
- Zhang W, Guo Y, Kuss M, et al. Platelet-rich plasma for the treatment of tissue infection: preparation and clinical evaluation. *Tissue Eng Part B*. 2019;25(3):225-236.
- Mahoney FI, Barthel DW. Functional evaluation. The Barthel index. *Md State Med J*. 1965;14:1461-1465.
- Hulsbæk S, Larsen LF, Rosthøj S, Kristensen MT. The Barthel Index and the Cumulated Ambulation Score are superior to the de Morton Mobility Index for the early assessment of outcome in patients with a hip fracture admitted to an acute geriatric ward. *Disabil Rehabil* 2019;41(11):1351-1359.
- Ryg J, Engberg H, Mariadas P, et al. Barthel index at hospital admission is associated with mortality in geriatric patients: a Danish nationwide population-based cohort study. *Clin Epidemiol*. 2018;10:1789-1800.
- Teasdale G, Allen D, Brennan P, McElhinney E, Mackinnon L. The Glasgow coma scale: an update after 40 years. *Nurs Times*. 2014;110:12-16.
- Islam MR, Khan SK, Rahman M, Talukder MH, Karim R, Salam A. Comparison of Glasgow Outcome Scale (GOS) and Glasgow Coma Scale (GCS) between surgical and conservative management of spontaneous supratentorial intracerebral hemorrhage patients: a randomized control trial. *J Curr Adv Med Res*. 2018;5(2):49-54.
- Gardner SE, Frantz RA, Bergquist S, Shin CD. A prospective study of the pressure ulcer scale for healing (PUSH). *J Gerontol*. 2005;60(1):93-97.
- Güneş ÜY. Kronik Yaraların Değerlendirilmesi. *C.Ü. Hemşirelik Yükseköğretim Dergisi*. 2007;11(3):38-44.
- Yılmaz B, Kesikburun S. Plateletten zengin plazma uygulamaları. *Türkiye Fiziksel Tıp Ve Rehabilitasyon Dergisi*. 2013;59:338-344.
- Örsçelik A. Spor yaralanmalarında plateletten zengin plazma uygulamaları. *Türkiye Klinikleri Sports-Med-Spec Top*. 2017;3(1):17-23.
- Jorge LA, Rodrigues AE, Arriba PD, Gisbert S, Abdalghany AA. Treatment with platelet-rich plasma of surgically related dormant corneal ulcers. *Eur J Ophthalmol*. 2018;28(5):515-520.
- Gonzales A, Costa TF, Andrade ZA, Medrado AR. Wound healing—a literature review. *An Bras Dermatol*. 2016;91(5):614-620.
- Thomas DR. Prevention and treatment of pressure ulcers. *JAMDA*. 2006;7(1):46-59.
- Turgut N, Ak A, Ak E, et al. Yoğun Bakım Hastalarında Basınç Ülseri Sıklığı, Önlenmesi Ve Tedavisi. *J Agent*. 2017;15(2):72-76.
- Chang MC, Yu T, Luo J, et al. Multimodal sensor system for pressure ulcer wound assessment and care. *IEEE Trans Ind Inform*. 2018;14(3):1186-1196.
- Hon J, Lagden K, McLaren A, et al. A prospective, multicenter study to validate use of the pressure ulcer scale for healing (PUSH) in patients with diabetic, venous, and pressure ulcers. *Ostomy Wound Manage*. 2010;56:26-36.
- Moore Z, Cowman S. Wound cleansing for pressure ulcers. *Cochrane Database Syst Rev*. 2013;(3):1-26. <https://doi.org/10.1002/14651858.CD004983.pub3>.
- Payne WG, Posnett J, Alvarez O, et al. A prospective, randomized clinical trial to assess the cost-effectiveness of a modern foam dressing versus a traditional saline gauze dressing in the treatment of stage II pressure ulcers. *Ostomy Wound Manage*. 2009;55(2):50-55.
- Griffiths RD, Fernandez RS, Ussia CA. Is tap water a safe alternative to normal saline for wound irrigation in the community setting? *J Wound Care*. 2013;10(10):407-411.
- Torreillas JR, Bertos DL, Martinez OG, Rodriguez LD, Luiz C. Use of platelet-rich plasma to treat pressure ulcers: a case study. *J Wound Ostomy Continence Nurs*. 2013;40(2):198-202.
- Tendas A, Niscola P, Giovannini M, et al. At home application of autologous platelet rich plasma as treatment for pressure sore and related anemia. *Cardiovasc Hematol Agents Med Chem*. 2017;14(2):90-93.

35. Raslan MM, Milad NM, AlAziz AA. Effect of autologous platelet-rich plasma in the promotion of healing of chronic ulcers. *Int Surg J*. 2018;5(1):15-19.
36. Singh R, Rohilla RK, Dhayal RK, Sen R, Sehkhal PK. Role of local application of autologous platelet-rich plasma in the management of pressure ulcers in spinal cord injury patients. *Spinal Cord*. 2014;52:809-816.
37. Mazzucco L, Medici D, Serra M, et al. The use of autologous platelet gel to treat difficult-to-heal wounds: a pilot study. *Transfusion*. 2004;44:1013-1018.
38. Anitua E, Aguirre JJ, Algorta J, et al. Effectiveness of autologous preparation rich in growth factors for the treatment of chronic cutaneous ulcers. *J Biomed Mater Res B Appl Biomater*. 2008;84:415-421.
39. Rapp L. Effect of platelet rich plasma gel in a physiologically relevant platelet concentration on wounds in persons with spinal cord injury. *Int Wound J*. 2011;8:187-195.
40. Sell SA, Ericksen JJ, Reis TW, Droste LW, Mohammed BA, Gater DR. A case report on the use of sustained release platelet-rich plasma for the treatment of chronic pressure ulcers. *J Spinal Cord Med*. 2011;34(1):122-127.
41. Russo CA, Steiner C, Spector W. Hospitalizations related to pressure ulcers among adults 18 years and older, 2006. Healthcare Cost and Utilization Project (HCUP), 2008.
42. Dougherty E. An evidence-based model comparing the cost-effectiveness of platelet-rich plasma gel to alternative therapies for patients with nonhealing diabetic foot ulcers. *Adv Skin Wound Care*. 2009;21(12):568-575.
43. El-Nagar A, Khalil A, El-Hawari A, Shehabeldin S, Bahaa A. Comparative study between negative pressure wound therapy and platelet rich plasma in neovascularization of chronic wound healing. *J Plast Reconstr Surg*. 2018;42(1):35-43.
44. Shaheen A. Platelet rich plasma (PRP) for treatment non-healing ulcers: a review study. *Austin J Dermatol*. 2018;5(1):1085.
45. Cobos R, Aizpuru F, Parraza N, Eduardo A, Gorka O. Effectiveness and efficiency of platelet rich plasma in the treatment of diabetic ulcers. *Curr Pharm Biotechnol*. 2015;16(7):630-634.

**How to cite this article:** Uçar Ö, Çelik S. Comparison of platelet-rich plasma gel in the care of the pressure ulcers with the dressing with serum physiology in terms of healing process and dressing costs. *Int Wound J*. 2020;17:831–841. <https://doi.org/10.1111/iwj.13344>