

Analysis of Factors Affecting the Outcome of Flap Reconstruction for Pressure Ulcers

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Abstract

Background: Pressure ulcers are a common and challenging problem affecting bed-ridden patients. Flap operations are considered a surgical option for treating pressure sores despite their high rate of complications and recurrence. Hypothesizing that certain factors would affect postoperative outcomes for pressure sore patients, we analyzed the factors and outcomes.

Methods: We collected cases retrospectively from January 2010 to January 2018. The subjects were 95 patients who had undergone flap operation in our institution. Patient demographics, wound characteristics, and outcomes including relapses, flap complications, reoperation, and newly developed sores were analyzed. Logistic regression analysis was used to identify the association between variables and surgical outcomes.

Results: Patients who had larger area of defects after debridement had more flap complications ($P=0.01$) and were more likely to undergo reoperation ($P=0.03$). Smokers ($P=0.04$) and patients whose wound cultures were positive ($P=0.04$) had more flap complications. Patients who had paralysis were more likely to require reoperation ($P=0.02$) and to develop new sores ($P=0.02$).

Conclusion: We identified factors affecting postoperative outcomes after flap operation to cover pressure sores. As a more comprehensive preoperative risk assessment on flap reconstruction for pressure sores can improve outcomes, these indicators should be carefully considered when determining surgical options.

Keywords: Pressure ulcer; Surgical flap; Reconstruction

Introduction

Pressure on any part of the body can damage the skin and underlying tissues, resulting in a pressure ulcer. Many hospitalized and long-term care patients suffer from pressure ulcers [1]. Considering the rising healthcare expenses and the burden on society in general [2-4], more efforts should be made to prevent the development of pressure ulcers in high-risk patients.

Flap operations are the typical treatment used to cover pressure ulcer wounds. Flaps are considered a good option because they provide sufficient volume and reliable vascular supply [5]. Since flap surgery has become the preferred treatment, few physicians consider the alternatives of primary closure or skin grafts.

However, complications after surgery is always a concern [6,7]. Complications may arise because of the condition of each patient, or due to the nature of a flap operation [8]. In addition, most patients with pressure ulcers are not capable of voluntary movement and suffer from general weakness [9]. These limitations mean that recurrence is common, and when ulcers recur, the range of options for coverage is reduced [10]. This compounds the need to reduce recurrence and complications when performing surgery, thereby decreasing the likelihood that the patient would need a reoperation. Several studies have investigated the risk factors of flap surgery; however, their popu-

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lations were limited to spinal cord injury patients, and the reported complication rates varied widely. Further, the previous studies evaluated the severity of recurrence or complications [10-13] insufficiently.

Postoperative outcomes must be anticipated when performing surgical treatment to cure or improve pressure ulcers [11]. We predicted that certain risk factors would correlate to different postoperative outcomes, such as relapse after a successful operation, complications after an operation, postoperative wounds that require reoperation, and newly developed pressure sores. In this study, we aimed to investigate the relationship between perioperative variables and postoperative outcomes to identify patients with higher risk of poor outcomes.

Methods

Medical charts of patients who underwent flap operations for pressure ulcers between January 2010 and February 2018 were reviewed retrospectively. Among the patients admitted to our department, we selected patients with an L89 diagnosis and subtypes associated with a decubitus ulcer, according to the ICD-10 (10th revision of the International Statistical Classification of Diseases and Related Health Problems) disease code. Only patients who had a flap surgery to cover the pressure sore were included. We excluded patients who had simple debridement, incision and drainage, and bursectomy, and those with pressure sores treated with conservative wound care. In addition, while patients whose pressure ulcer wounds underwent primary repair or skin grafts were also excluded, patients who underwent primary repair or skin graft at the donor site were included. This study was performed in accordance with the principles of the Declaration of Helsinki. The study and all its protocols were approved by the Institutional Review Board of Ajou Medical Center (IRB No. AJIRB-MED-MDB-17-254). The need for informed consent was waived by the institutional review board of our hospital due to the retrospective design of the study.

The following demographic information on the patients were collected: age, sex, body mass index (BMI), weight, comorbidities (diabetes and end-stage renal disease [ESRD]), smoking, paralysis (previously diagnosed paraplegia, hemiplegia, and quadriplegia), and serum albumin and hemoglobin level. Patients' activity levels were evaluated by the Eastern Cooperative Oncology Group (ECOG) performance status and Braden scale score. In terms of wound characteristics, wound area size, culture results, and location were noted. The

wound area was assessed from the measurements for designing the flaps for during reconstruction. The culture tests were routinely obtained on the first day of hospitalization.

Postoperative outcomes included relapse, complications, reoperation, and a newly developed sore at other sites. Surgical complications were defined as all surgery-related problems, including wound dehiscence, infection, necrosis, hematoma, and seroma. A relapse was defined as a pressure sore reoccurring during follow-up in the same area after flap reconstruction. Reoperation was defined as the surgical site being reoperated upon, owing to complications or relapse. Reoperations included debridement, primary closure, and flap surgery, and its necessity was determined at the discretion of the surgeon. If the surgeon decided that the wound could not heal with conservative treatment, it was given a reoperation. Pressure sores occurring in other areas during follow-up were also considered.

R language version 3.3.3 (R Foundation for Statistical Computing, Vienna, Austria) and T&F program ver. 2.2 (YooJin BioSoft, Goyang, Korea) were used for all statistical analyses. Data were expressed as mean \pm standard deviation (SD) for continuous variables. For categorical variables, data were expressed as sample number and percentage, number (%). When continuous variables were normally distributed, a mean difference test between two subgroups of outcomes was performed using the Student t-test. For non-normally distributed variables, the Mann-Whitney U test was used. For categorical variables, chi-square test or Fisher exact test were performed to test the hypothesis of association between outcome and other variables as appropriate, using contingency tables. For analyzing the combined effect on the outcome of more than two variables, multivariable linear regression analysis was performed using backward stepwise procedure. To analyze the effect of each clinical measurement on the binary outcomes of relapse, flap complication, reoperation, or new sore development, binary logistic regression analysis was performed. For analyzing the combined effect of more than two variables on the binary outcome, multivariable logistic regression analysis was performed using backward stepwise procedure.

Results

During the period included in the study, a total of 757 patients had surgery for pressure ulcers in our department. The 384 patients who had only simple debridement, incision and drainage, and bursectomy were excluded, and 278 who had

Table 1. Characteristics of demographic and clinical variables

Variable	Subgroup	No. (%)
Age, mean±SD (yr)		53.95±9.44
Sex	Female	40 (42.1)
	Male	55 (57.9)
BMI (kg/m ²)	<20	29 (30.5)
	20 to <25	47 (49.5)
	25 to <30	13 (13.7)
	≥30	6 (6.3)
Weight, mean±SD (kg)		60.81±6.87
Diabetes	No	69 (72.6)
	Yes	26 (27.4)
ESRD	No	89 (93.7)
	Yes	6 (6.3)
Smoker	No	79 (83.2)
	Yes	16 (16.8)
Paralysis	No	57 (60.0)
	Yes	38 (40.0)
ECOG performance status	1	13 (13.7)
	2	15 (15.8)
	3	19 (20.0)
	4	48 (50.5)
Albumin, mean±SD (g/dL)		3.55±0.32
	<3.0	22 (23.2)
	3.0 to <3.5	20 (21.1)
	3.5 to <5.2	53 (55.8)
Hemoglobin, mean±SD (g/dL)		11.31±0.90
	<10.7	39 (41.1)
	10.7–15.3	55 (57.9)
	>15.3	1 (1.1)
Braden scale, mean±SD		13.80±1.49
	Severe risk	6 (6.3)
	High risk	20 (21.1)
	Moderate risk	33 (34.7)
	Mild risk	28 (29.5)
No risk	8 (8.4)	
Area, mean±SD (cm ²)		29.09±18.80
Culture	Negative	55 (57.9)
	Positive	40 (42.1)
Site	Ischial area	22 (23.2)
	Sacral area	59 (62.1)
	Trochanter	14 (14.7)

(Continued to the next)

Table 1. Continued

Variable	Subgroup	No. (%)
Relapse	No	75 (78.9)
	Yes	20 (21.1)
Flap complication	No	78 (82.1)
	Yes	17 (17.9)
Reoperation	No	68 (71.6)
	Yes	27 (28.4)
Sore newly developed on other sites	No	88 (92.6)
	Yes	7 (7.4)

BMI, body mass index; ESRD, end-stage renal disease; ECOG, Eastern Cooperative Oncology Group.

primary repair or skin graft instead of a flap surgery were also excluded. The remaining 95 patients who had a flap operation for pressure ulcers were ultimately included in the retrospective case-control study.

The patient demographics are summarized in Table 1. The mean age was 53.95 years. There were 55 male patients, accounting for 57.9% of the sample. Twenty-nine patients (30.5%) had a BMI of 20 kg/m² or less, thirteen patients (13.7%) recorded a BMI between 25–30 kg/m², and six patients (6.3%) had a BMI over 30 kg/m². Of the comorbidities, 26 patients (27.4%) had diabetes and 6 (6.3%) had ESRD. There were 16 smokers (16.8%) in this study. Thirty-eight patients (40%) had paralysis, and forty-eight patients (50.5%) had an ECOG score of 4. Patients whose levels of albumin (≤3.0 g/dL) and hemoglobin (<10.7 g/dL) were below normal amounted to 22 (23.2%) and 39 (41.1%) patients, respectively. The Braden scale scores were 6 (6.3%), 20 (21.1%), and 33 (34.7%) for the severe, high, and moderate risk groups, respectively.

The average defect size of the wounds was 29.09 cm² (±18.80) culture result was positive in 40 patients (42.1%) and the location of the sores were in the ischial area for 22 patients (23.2%), in the sacral area for 59 patients (62.1%), and in the trochanter area for 14 patients (14.7%). The recurrence rate of pressure ulcers in the same area after flap reconstruction was 20.1%. Flap complications occurred in 17 patients (17.9%). There were 27 patients (28.4%) who had relapses or flap complications to the extent that they had to receive reoperations, and 7 patients (7.4%) developed pressure sore at other sites during the follow-up.

Table 2 shows the effects of clinical variables on flap complication occurrence. Sore size and smoking positively correlated with flap complications, while age, Braden scale score, albu-

Table 2. Analysis of effects of clinical variables on flap complication occurrence

Variable	Subgroup	Flap complications, No. (%)		Unadjusted analysis		Adjusted analysis	
		No	Yes	OR (95% CIs)	P-value	OR (95% CIs)	P-value
Age, mean ± SD (yr)		54.51 ± 2.14	51.35 ± 4.68	1.009 (0.981–1.037)	0.53	1.018 (0.982–1.055)	0.54
Sex					0.16		0.32
	Female	31 (39.7)	9 (52.9)	1		1	
	Male	47 (60.3)	8 (47.1)	0.321 (0.066–1.567)		0.586 (0.204–1.684)	
ECOG performance status					0.41		0.35
	1	10 (12.8)	3 (17.6)	1		1	
	2	13 (16.7)	2 (11.8)	0.991 (0.231–4.247)		0.513 (0.072–3.677)	
	3	18 (23.1)	1 (5.9)	1.932 (0.377–9.900)		0.185 (0.017–2.024)	
	4	37 (47.4)	11 (64.7)	5.351 (0.640–44.725)		0.991 (0.231–4.247)	
Paralysis					0.83		0.51
	No	48 (61.5)	9 (52.9)	1		1	
	Yes	30 (38.5)	8 (47.1)	1.079 (0.541–2.153)		1.422 (0.495–4.089)	
BMI (kg/m ²)					0.33		0.25
	<20	24 (30.8)	5 (29.4)	4.800 (0.741–31.081)		1.190 (0.340–4.173)	
	20 to <25	40 (51.3)	7 (41.2)	1		1	
	25 to <30	11 (14.1)	2 (11.8)	5.714 (0.954–34.242)		1.039 (0.188–5.729)	
	≥30	3 (3.8)	3 (17.6)	5.500 (0.611–49.535)		5.714 (0.954–34.243)	
Weight, mean ± SD (kg)		60.47 ± 1.59	62.38 ± 3.11	0.990 (0.953–1.028)	0.60	1.069 (0.948–1.205)	0.61
Diabetes					0.82		1.00
	No	57 (73.1)	12 (70.6)	1		1	
	Yes	21 (26.9)	5 (29.4)	1.198 (0.244–5.891)		1.131 (0.356–3.597)	
ESRD					0.69		1.00
	No	73 (93.6)	16 (94.1)	1		1	
	Yes	5 (6.4)	1 (5.9)	0.564 (0.035–9.067)		0.912 (0.100–8.353)	
Smoker					0.02 ^{a)}		0.04 ^{a)}
	No	68 (87.2)	11 (64.7)	1		1	
	Yes	10 (12.8)	6 (35.3)	7.178 (1.459–35.309)		3.709 (1.122–12.264)	
Culture					0.07		0.04 ^{a)}
	Negative	49 (62.8)	6 (35.3)	1		1	
	Positive	29 (37.2)	11 (64.7)	3.570 (0.897–14.205)		3.098 (1.036–9.265)	
Site					0.91		0.86
	Ischial area	19 (24.4)	3 (17.6)	1		1	
	Sacral area	48 (61.5)	11 (64.7)	1.525 (0.228–10.209)		1.451 (0.364–5.785)	
	Trochanter	11 (14.1)	3 (17.6)	1.203 (0.265–5.461)		1.727 (0.296–10.082)	
Area, mean ± SD (cm ²)		23.68 ± 3.35	53.96 ± 13.91	0.983 (0.969–0.996)	0.01 ^{b)}	0.978 (0.957–0.999)	0.01 ^{b)}
Braden scale					1.00		0.81
	Severe risk	6 (7.7)	0	1		1	
	High risk	16 (20.5)	4 (23.5)	-		3.545 (0.166–75.580)	
	Moderate risk	27 (34.6)	6 (35.3)	1.000 (0.086–11.588)		3.679 (0.185–73.058)	
	Mild risk	23 (29.5)	5 (29.4)	0.929 (0.089–9.687)		3.043 (0.148–62.509)	
	No risk	6 (7.7)	2 (11.8)	1.150 (0.105–12.616)		4.333 (0.142–132.320)	
Albumin (g/dL)					0.52		0.63
	<3.0	19 (24.4)	3 (17.6)	0.577 (0.113–2.934)		0.772 (0.188–3.172)	
	3.0 to <3.5	15 (19.2)	5 (29.4)	2.225 (0.661–7.482)		1.630 (0.471–5.634)	
	3.5 to <5.2	44 (56.4)	9 (52.9)	1		1	
Hemoglobin (g/dL)					0.20		0.27
	≥10.7	48 (61.5)	8 (47.1)	1		1	
	<10.7	30 (38.5)	9 (52.9)	2.225 (0.661–7.482)		1.800 (0.626–5.175)	

Odds ratio (OR) and 95% confidence intervals (CIs) computed in the subsample of flap complication; No vs. yes, P-value computed using Student t-test and Mann-Whitney U test in continuous variables; P-value computed using chi-square test and Fisher exact test in categorical variables, age, weight, and area were continuous variables and expressed mean ± SD. ECOG, eastern cooperative oncology group; BMI, body mass index; ESRD, end-stage renal disease.

^{a)}P < 0.05; ^{b)}P < 0.01.

Table 3. Analysis of effects of clinical variables on reoperation

Variable	Subgroup	Reoperation, No. (%)		Unadjusted analysis		Adjusted analysis	
		No	Yes	OR (95% CIs)	P-value	OR (95% CIs)	P-value
Age, mean ± SD (yr)		55.56 ± 2.38	49.89 ± 3.20	1.016 (0.992–1.041)	0.19	1.012 (0.975–1.050)	0.19
Sex					0.75		0.87
	Female	29 (42.6)	11 (40.7)	1		1	
	Male	39 (57.4)	16 (59.3)	0.749 (0.123–4.547)		1.082 (0.437–2.675)	
ECOG performance status					0.64		0.95
	1	10 (14.7)	3 (11.1)	1		1	
	2	10 (14.7)	5 (18.5)	0.436 (0.056–3.418)		1.667 (0.311–8.929)	
	3	14 (20.6)	5 (18.5)	0.388 (0.069–2.163)		1.190 (0.230–6.170)	
	4	34 (50.0)	14 (51.9)	0.477 (0.084–2.698)		1.373 (0.328–5.750)	
Paralysis					0.03 ^{a)}		0.02 ^{a)}
	No	46 (67.6)	11 (40.7)	1		1	
	Yes	22 (32.4)	16 (59.3)	6.380 (1.256–32.409)		3.041 (1.211–7.636)	
BMI (kg/m ²)					0.82		0.70
	<20	19 (27.9)	10 (37.0)	2.790 (0.026–294.553)		1.722 (0.621–4.781)	
	20 to <25	36 (52.9)	11 (40.7)	1		1	
	25 to <30	9 (13.2)	4 (14.8)	3.050 (0.076–121.812)		1.455 (0.374–5.654)	
	≥30	4 (5.9)	2 (7.4)	4.513 (0.164–124.332)		1.636 (0.263–10.168)	
Weight, mean ± SD (kg)		61.21 ± 1.74	59.83 ± 2.41	1.021 (0.936–1.114)	0.64	1.025 (0.983–1.068)	0.66
Diabetes					0.92		0.84
	No	49 (72.1)	20 (74.1)	1		1	
	Yes	19 (27.9)	7 (25.9)	1.083 (0.215–5.466)		0.903 (0.329–2.480)	
ESRD					1.00		0.84
	No	62 (91.2)	27 (100)	1		1	
	Yes	6 (8.8)	0	-		0.903 (0.329–2.480)	
Smoker					0.07		0.38
	No	58 (85.3)	21 (77.8)	1		1	
	Yes	10 (14.7)	6 (22.2)	4.348 (0.883–21.402)		1.657 (0.536–5.122)	
Culture					0.77		0.28
	Negative	37 (54.4)	18 (66.7)	1		1	
	Positive	31 (45.6)	9 (33.3)	0.800 (0.179–3.579)		0.597 (0.235–1.515)	
Site					0.26		0.39
	Ischial area	14 (20.6)	8 (29.6)	1		1	
	Sacral area	45 (66.2)	14 (51.9)	4.458 (0.564–35.211)		0.544 (0.189–1.565)	
	Trochanter	9 (13.2)	5 (18.5)	4.089 (0.691–24.196)		0.972 (0.241–3.928)	
Area, mean ± SD (cm ²)		25.92 ± 4.75	37.08 ± 6.27	0.984 (0.969–1.000)	0.06	0.985 (0.971–0.999)	0.03 ^{a)}
Braden scale					0.54		0.78
	Severe risk	3 (4.4)	3 (11.1)	1		1	
	High risk	15 (22.1)	5 (18.5)	0.286 (0.100–8.259)		0.333 (0.050–2.214)	
	Moderate risk	25 (36.8)	8 (29.6)	1.078 (0.062–18.886)		0.375 (0.064–2.211)	
	Mild risk	21 (30.9)	7 (25.9)	2.055 (0.160–26.324)		0.400 (0.066–2.415)	
	No risk	4 (5.9)	4 (14.8)	0.796 (0.058–10.850)		0.667 (0.060–7.352)	
Albumin (g/dL)					0.33		0.29
	<3.0	18 (26.5)	4 (14.8)	0.269 (0.031–2.376)		0.563 (0.163–1.940)	
	3.0 to <3.5	12 (17.6)	8 (29.6)	0.225 (0.030–1.668)		1.689 (0.576–4.953)	
	3.5 to <5.2	38 (55.9)	15 (55.6)	1		1	
Hemoglobin (g/dL)					0.24		0.18
	≥10.7	43 (63.2)	13 (48.1)	1		1	
	<10.7	25 (36.8)	14 (51.9)	1.834 (0.664–5.063)		1.852 (0.752–4.563)	

Odds ratio (OR) and 95% confidence intervals (CIs) computed in the subsample of flap complication; No vs. yes, P-value computed using Student t-test and Mann-Whitney U test in continuous variables; P-value computed using chi-square test and Fisher exact test in categorical variables, age, weight, and area were continuous variables and expressed mean ± SD. ECOG, eastern cooperative oncology group; BMI, body mass index; ESRD, end-stage renal disease.

^{a)}P < 0.05.

Table 4. Analysis of effects of clinical variables on different site sore development

Variable	Subgroup	Developing sore of other sites, No. (%)		Unadjusted analysis		Adjusted analysis	
		No	Yes	OR (95% CIs)	P-value	OR (95% CIs)	P-value
Age, mean±SD (yr)		54.05±19.31	52.71±13.31	1.004 (0.964–1.045)	0.85	0.955 (0.852–1.071)	0.43
Sex					0.46		0.70
	Female	38 (43.2)	2 (28.6)	1		1	
	Male	50 (56.8)	5 (71.4)	1.900 (0.349–10.330)		1.900 (0.349–10.330)	
ECOG performance status					0.91		0.84
	1	13 (14.8)	0	1		1	
	2	14 (15.9)	1 (14.3)	1.914 (0.262–14.000)		2.793 (0.105–74.630)	
	3	18 (20.5)	1 (14.3)	1.628 (0.175–15.141)		2.189 (0.083–57.985)	
	4	43 (48.9)	5 (71.4)	2.093 (0.228–19.202)		3.414 (0.177–65.801)	
Paralysis					0.03 ^{a)}		0.02 ^{a)}
	No	56 (63.6)	1 (14.3)	1		1	
	Yes	32 (36.4)	6 (85.7)	10.500 (1.210–91.147)		10.500 (1.210–91.151)	
BMI (kg/m ²)					0.42		0.85
	<20	26 (29.5)	3 (42.9)	1.053 (0.164–6.776)		1.240 (0.257–5.987)	
	20 to <25	43 (48.9)	4 (57.1)	1		1	
	25 to <30	13 (14.8)	0	0.611 (0.098–3.797)		0.358 (0.018–7.084)	
	≥30	6 (6.8)	0	0.889 (0.113–7.016)		0.744 (0.036–15.480)	
Weight (kg)		61.07±14.12	57.57±7.50	1.020 (0.961–1.082)	0.52	0.776 (0.548–1.099)	0.15
Diabetes					0.70		1
	No	64 (72.7)	5 (71.4)	1		1	
	Yes	24 (27.3)	2 (28.6)	0.618 (0.056–6.838)		1.067 (0.194–5.872)	
ESRD					-		1
	No	82 (93.2)	7 (100)	1		1	
	Yes	6 (6.8)	0	-		0.846 (0.043–16.527)	
Smoker					0.69		1
	No	73 (83.0)	6 (85.7)	1		1	
	Yes	15 (17.0)	1 (14.3)	0.427 (0.007–26.650)		0.811 (0.091–7.238)	
Culture					0.87		0.70
	Negative	50 (56.8)	5 (71.4)	1		1	
	Positive	38 (43.2)	2 (28.6)	1.473 (0.012–175.900)		0.526 (0.097–2.862)	
Site					0.55		0.53
	Ischial area	21 (23.9)	1 (14.3)	1		1	
	Sacral area	55 (62.5)	4 (57.1)	2.292 (0.376–13.984)		1.527 (0.161–14.466)	
	Trochanter	12 (13.6)	2 (28.6)	3.500 (0.286–42.769)		3.500 (0.286–42.771)	
Area (cm ²)		28.79±38.53	32.86±24.20	0.997 (0.979–1.016)	0.79	0.993 (0.961–1.025)	0.66
Braden scale					0.66		0.73
	Severe risk	5 (5.7)	1 (14.3)	1		1	
	High risk	18 (20.5)	2 (28.6)	0.750 (0.078–7.210)		0.556 (0.041–7.457)	
	Moderate risk	31 (35.2)	2 (28.6)	0.500 (0.064–3.906)		0.500 (0.043–5.813)	
	Mild risk	28 (31.8)	0	0.562 (0.080–3.939)		0.185 (0.010–3.473)	
	No risk	6 (6.8)	2 (28.6)	0.600 (0.084–4.294)		0.333 (0.011–10.108)	
Albumin (g/dL)					0.18		0.43
	<3.0	21 (23.9)	1 (14.3)	0.021 (0.000–1.340)		0.794 (0.078–8.075)	
	3.0 to <3.5	17 (19.3)	3 (42.9)	0.165 (0.090–2.691)		2.941 (0.541–15.976)	
	3.5 to <5.2	50 (56.8)	3 (42.9)	1		1	
Hemoglobin (g/dL)					0.04 ^{a)}		0.02 ^{a)}
	≥10.7	55 (62.5)	1 (14.3)	1		1	
	<10.7	33 (37.5)	6 (85.7)	10.000 (1.153–86.759)		10.000 (1.153–86.762)	

Odds ratio (OR) and 95% confidence intervals (CIs) computed in the subsample of flap complication; No vs. yes, P-value computed using Student t-test and Mann-Whitney U test in continuous variables; P-value computed using chi-square test and Fisher exact test in categorical variables, age, weight, and area were continuous variables and expressed mean±SD. ECOG, eastern cooperative oncology group; BMI, body mass index; ESRD, end-stage renal disease.

^{a)}P<0.05.



Fig. 1. Preoperative photograph of pressure sore. After debridement, soft tissue defect was about 4×4 cm.



Fig. 2. Immediate postoperative photograph of pressure sore. The defect was covered by superior gluteal artery based fasciocutaneous flap.

min levels, hemoglobin levels, and weight were not significantly related.

The relationships between clinical variables and the need for reoperation (Table 3) or new ulcer occurrence (Table 4) are each presented in subsequent tables. Patients with paralysis had a significant likelihood of reoperation and new pressure ulcer occurrence at other locations. In the adjusted model, patients with a larger wound tended to undergo reoperation. Other variables did not show any significant results. Relapse did not show any significant correlation with any variable.

Discussion

Open wounds from pressure ulcers cause various problems for patients. Pressure ulcers decrease the quality of life and can cause wound site infection, leading to increased mortality and length of hospital stay [14]. For example, Espejo et al. [14] demonstrated that there was a correlation between compression ulcers and bacteremia associated with mortality using a prospective study design.

Many plastic surgeons are aware of these problems and have explored how to optimally cover open wounds caused by pressure ulcers. Patients with severe pressure ulcers that fail to heal require surgery to fill the wounds and prevent any further tissue damage. A variety of reconstructive options are available, such as split thickness skin grafting, local flaps, regional flaps, and microvascular free flaps [15]. With improved understanding of vascularity, flap surgery has become popular, because it can provide rich soft tissue and is therefore more favorable

than primary closure of skin graft for covering pressure sore wounds (Figs. 1, 2). However, complication rates after flap coverage make it difficult to determine which treatment option is most suitable.

The possibility of postoperative complications after flap surgery turned out to vary widely among different studies. In the study of Bamba et al. [11], the probability of flap complication after coverage was 52%. Other studies reported the incidence of complications to be 21%, 29%, 82%, and 39%.

In this study, the larger the defect size created after the last debridement operation before the flap surgery, the higher the probability of flap complications and need for reoperation. The larger the defect, the larger a flap was required to cover the wound. Although the wound size has not been specifically indicated as a risk factor in pressure sore reconstruction, it has already been identified as an important risk factor in flap reconstruction [16]. In addition, large wounds are inherently more prone to infection and wound dehiscence; therefore, the risk of reoperation is high in these cases.

Flap complications were also more common in smokers. Compared with nonsmokers, smokers are known to have worse microcirculation and more frequent complications of flap surgery including flap necrosis and failure [17]. Among the risk factors identified in this study, smoking is the only one that patients can modify. Therefore, surgeons should induce patients to quit smoking before the surgery by recommending appropriate smoking cessation programs.

The probability of complications was high when bacteria was identified in the wound culture before surgery. Patients

with a positive intraoperative culture are known to have an increased rate of infection [18,19]. In general, patients who are indicated for surgery to cover a pressure sore are those who do not have any acute medical problems, with no purulent infection at the wound site and well-formed granulation tissue [20]. We also performed surgery on patients whose wounds were relatively clean and well-managed without pus on evaluation. While no patient in this study had purulent wounds, 42.1% showed positive culture swab tests on the first day of hospitalization. Therefore, using appropriate antibiotics according to the culture test results may help reduce postoperative complications.

We considered factors such as BMI, albumin, and hemoglobin to assess the nutritional status of patients. Generally, severe malnutrition can be a risk factor for the development of pressure ulcers [21]. However, no correlation was found between nutritional factors and probability of complications in this study. Among the many ways to assess nutritional status, in this study we used the conventional indicators mentioned above. However, because these indicators are controversial in terms of sensitivity and specificity [22], further research using criteria that better reflect malnutrition is needed.

The limitations of this study mainly owe to its retrospective nature. Furthermore, outcomes such as reoperation were influenced by preference of the surgeons. Also, we focused on complications described in the medical records, meaning that complications that are easily overlooked may have been omitted. Further, according to the protocol in our department, we routinely perform a culture test on the first day of hospitalization. However, in one third of patients, intraoperative culture tests were not performed. Considering the rate of false positives in swab tests in wound cultures, a strong correlation between infection and complications could have been revealed if an intraoperative culture test were performed. It is also unfortunate that there was insufficient long-term follow-up because of the characteristics of patients with pressure ulcers, such as difficulty in accessing the hospital, or instances of those who died at home or other institutions before the follow-up. Although we found significant results from several factors, it is hard to determine the impact of confounding variables such as types of flaps, composition, method of movement, and proximity to defect.

Only a limited number of patients with pressure sores were eligible for flap surgery. Most patients with pressure ulcers already had general deterioration or spinal cord injury, increasing the probability of postoperative recurrence and making

complication management difficult.

This study also confirmed that patients with paralysis were likely to need reoperation or suffer pressure ulcers in other areas. The size of the defect area also significantly increased the risk of flap complication and reoperation. Close monitoring should be performed in patients with paralysis or large defect areas. We revealed that smoking and infection increase the incidence of flap complications. Smoking cessation and adequate infection control will help reduce these risks. This study analyzed the factors affecting flap operation on pressure ulcers, aiming to contribute to more successful outcomes by raising awareness of significant factors before operation.

Complications after surgery for covering pressure ulcers are considered important because they can slow down wound recovery and put the donor site at risk. In this study, we investigated the factors influencing outcomes after flap surgery on an area damaged by a pressure ulcer. These results can be helpful in identifying patients prone to postoperative complications and in establishing surgical strategies to address risks.

Conflict of interest

No potential conflict of interest relevant to this article was reported.

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