

ORIGINAL**Risk factors for early wound dehiscence by surgical site infection after pressure ulcer surgery**

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Abstract : **Aims :** The most common postoperative complication when treating a pressure ulcer with a flap or primary closure is early wound dehiscence. In this study, we aimed to investigate the cause of early wound dehiscence and its associated risk factors. Early wound dehiscence was defined as the wound dehiscence within the post operation period where no weight or tension is applied to the wound. **Methods :** We conducted a retrospective study of 40 patients with pressure ulcers (69 sites). We calculated the significant difference in the incidence of wound dehiscence between the groups for the following 15 factors : age, obesity, emaciation, diabetes mellitus, smoking, ulcer site, musculocutaneous flap, methicillin-resistant *Staphylococcus aureus*, presence of two or more types of bacteria, albumin level, C-reactive protein level, white blood cell count, hemoglobin level, operative time, and ulcer size. **Results :** Bacteria were detected in all wounds with early dehiscence, which was found in 28 (40.6%) of the 69 cases. C-reactive protein level, albumin level, musculocutaneous flap, and operative time were found to be risk factors for early wound dehiscence using the χ^2 -test and t-test. (P = 0.011, 0.045, 0.018, and 0.003, respectively). **Conclusion :** The cause of dehiscence was considered to be surgical site infection. C-reactive protein level, albumin level, musculocutaneous flap, and operative time may be risk factors of the occurrence of early wound dehiscence. *J. Med. Invest.* 70:101-104, February, 2023

Keywords : *pressure ulcer, decubitus ulcer, flap, wound dehiscence, surgical site infection, risk factor*

INTRODUCTION

The most common postoperative complication when treating a pressure ulcer with a flap is wound dehiscence (1). There have been several reports on the risk factors for complications after treating pressure ulcers with flaps in the past. It has been reported that the cause of postoperative complications after surgery depends on the location of the pressure ulcers and the weight and nutritional status of the patient (1-5). These previous studies have highlighted that wound dehiscence, specifically after the application of weight on the reconstructed site, is affected by the pressure ulcer site and the patient's body mass index (BMI) and age. However, no reports have focused on early wound dehiscence within three weeks of the operation ; the period where no weight or tension is applied to the wound. We hypothesize that there are different factors involved in early wound dehiscence during periods when the application of weight and tension to the wound is prohibited ; infection is suspected to be the most likely cause. The purpose of this study was to investigate the cause of early wound dehiscence and its associated risk factors.

METHODS

This study was approved by the Ethics Committee of our University. Consent was obtained from the participants for the publication of their case details. We conducted this retrospective study of 40 patients with pressure ulcers (69 sites) with flaps or primary closure treated at our hospital between 2005 and

2018. We investigated the following factors in the patients : 1) age, 2) obesity (BMI > 30), 3) emaciation (BMI < 15), 4) diabetes mellitus, 5) smoking, 6) ulcer site (ischial, sacral, or other), 7) presence of musculocutaneous (muscle) flap, 8) detection of methicillin-resistant *Staphylococcus aureus* (MRSA) in the wound, 9) detection of two or more types of bacteria regardless of whether it contain MRSA or not in the wound, 10) albumin levels, 11) C-reactive protein (CRP) levels, 12) white blood cell (WBC) count, 13) hemoglobin levels, 14) operative time, and 15) ulcer size. These factors were analyzed to investigate if there were significant differences in the incidence of early wound dehiscence between groups that did and did not exhibit them. All factors were preoperative. Bacterial testing was performed on all pre-operative pressure ulcers and postoperative wounds with early dehiscence. The presence or absence of MRSA and the number of bacterial species detected in wounds with early dehiscence was investigated after surgery. Early wound dehiscence was defined as wound dehiscence during periods when repositioning and activity were restricted to avoid the application of weight and tension to the wound. At our facility, all postoperative patients with pressure ulcer surgery were restricted from head-up or sitting for a minimum of three weeks. The return to wheelchair was permitted after at least four weeks (1). Deep wounds that reached the subcutaneous tissue (two centimeters or more) were considered dehiscence wounds. This study excluded cases of early wound dehiscence due to flap necrosis. Sensitive antibiotics were administered in all cases based on the results of the pre-operative bacterial culture testing. The administration period was until the fever subsided after the operation and the WBC count returned within the normal range. The average duration of antibiotic administration period was 4.65 (range : 2–14) days. All surgeries were performed by a plastic surgeon or a senior resident under the guidance of a plastic surgeon. We first performed debridement for ulcers with necrosis or signs of infection and additional removal of wound surfaces and reconstruction surgery when the infection subsided and the granulation of the

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wound improved. We stained the ulcer surface with pyoktatin blue before debridement at wound closure and then performed debridement to completely remove the stained tissue (2). If the bone was found exposed in the ulcer, we performed preoperative CT or MRI to determine the extent of the debridement so that we could resect the decayed bone and osteomyelitis.

STATISTICAL ANALYSIS

The outcomes were assessed using t-tests and χ^2 -tests. Statistical significance was achieved at two-tailed P-values below 0.05. Statistical analyses were conducted using SPSS 16.0 (SPSS Inc.).

RESULTS

The patient demographics, wound characteristics, operative times, bacterial cultures, and early wound dehiscence incidence are summarized in Table 1. The details of the flap used for reconstruction are shown in Table 2. Tensor fascia lata was distinguished from myocutaneous or muscle flap because the flap covering the ulcer did not contain muscle. In primary closure, dehiscence was observed in three out of 15 cases (20%).

Early wound dehiscence was found in 28 (40.1%) of the 69 cases. The early wound dehiscence occurred after an average of 9.12 (range : 2–21) postoperative days. We performed bacterial cultures in 19 cases of the 28 wound dehiscence cases. Bacteria were detected in all 19 wounds with early dehiscence. MRSA was detected in 6 cases of 19 cases. Two or more types were detected in 9 cases of 19 cases. As a result of the t-tests and χ^2 -tests, CRP levels, albumin levels, musculocutaneous flap, and operative time were found to be risk factors of early wound dehiscence ($P = 0.011, 0.045, 0.018, \text{ and } 0.003$, respectively). No significant difference was found in other factors (Table 3).

DISCUSSION

Despite efforts to facilitate wound healing by avoiding the application of weight and tension on the reconstructed site for three weeks after the pressure ulcer surgery, early wound dehiscence often ensues (3). There are reports of factors related to lengthy postoperative complications of pressure ulcers such as the albumin level and ulcer site, and the patient's body weight and diabetes status (3-7). We hypothesized that the cause of early wound dehiscence that occurs immediately after surgery and the cause of long-term wound dehiscence after discharge would vary due to the respective absence and presence of the application of weight or tension to the wound.

A surgical site infection (SSI) is defined as a postoperative infection that occurs in the part of the body where the surgery took place (8). We considered SSI to be the cause of early wound dehiscence when bacteria were detected in the wound. In our study, bacteria were detected in all wounds with early dehiscence. Therefore, we concluded that the cause of early wound dehiscence was wound infection, which verifies our hypothesis. It is possible that incisional negative pressure wound therapy, which is effective in preventing SSI, may reduce dehiscence (9).

Several papers report the relationship between surgery time and SSI (10-12). Longer operating time might serve as a marker for the complexity of the surgery, prolonged exposure to microorganisms in the operating environment, and diminished efficacy of antimicrobial prophylaxis (13). The fact that operative time was a risk factor for early wound dehiscence in our study

Table 1. Epidemiology of all patients undergoing pressure ulcer reconstruction.

| Variables | 40 patients (69 sites) |
|---|---|
| Sex | Male : 25 (38 sites : 55.1%) Female : 15 (31 sites : 44.9%) |
| Age at surgery (years) | Mean 59.0 \pm 16.4 (range : 14-90) |
| BMI | Obesity (BMI > 30) : 4 (5.8%) Emaciation (BMI < 18.5) : 17 (24.6%) Other : 48 (69.6%) |
| Diabetes mellitus | [+] : 11 sites (15.9%), [-] : 58 sites (84.1%) Mean HbA1c : 6.27 \pm 0.47 |
| Smoking | [+] : 13 patients [current smoker 7, non-current smoker 6], 27 sites (39.1%) [-] : 17 patients, 42 sites (60.9%) |
| Site | Ischial : 32 (46.4%) Sacral : 15 (21.7%) Other : 22 (31.9%) |
| Reconstruction | Musculocutaneous (muscle) flap : 11 (15.9%) Other : 58 (84.1%) |
| Bacterial species detected in the wound | |
| MRSA | [+] : 25 (36.2%), [-] : 44 (63.8%) |
| Multiple bacterial species | [+] : 34 (49.3%), [-] : 35 (50.7%) |
| Blood test | |
| Albumin (g/dl) | 3.14 \pm 0.50 (range : 1.9-4.0) |
| CRP (mg/dl) | 2.27 \pm 2.61 (range : 0.15-11.76) |
| WBC ($\times 1000/\mu\text{l}$) | 6.4 \pm 2.33 (range : 2.4-13.7) |
| Hb (g/dl) | 11.30 \pm 2.07 (range : 7.4-14.6) |
| Operative time (min) | 195.1 \pm 111.4 (range : 26-703) |
| Ulcer size (major \times minor axis cm^2) | 31.01 \pm 30.66 (range : 1-150) |

BMI, body mass index ; CRP, C-reactive protein ; Hb, Hemoglobin ; MRSA, methicillin-resistant Staphylococcus aureus ; WBC, white blood cell

Table 2. Details of pressure ulcer reconstruction

| Flap type or primary closer | Case number |
|--|-------------|
| Musculocutaneous (muscle) flap | 11 |
| Gluteus maximus myocutaneous flap | 7 |
| Gluteus maximus muscle flap | 1 |
| Rectus abdominis muscle flap | 1 |
| Glacillis myocutaneous flap | 1 |
| Gluteus maximus myocutaneous + glacillis muscle flap | 1 |
| Others | 58 |
| Tensor fascia lata musculocutaneous flap | 4 |
| Posterior thigh flap | 6 |
| Lateral calcaneal flap | 1 |
| Advancement flap | 5 |
| Transposition flap | 23 |
| Rotation flap | 5 |
| primary closure | 15 |

Table 3. The variables investigated against early wound dehiscence

| Variables | Early wound dehiscence (+/-) | P-value |
|--|------------------------------|---------|
| Sex male | (+) : 18 (-) : 30 | 0.528 |
| female | (+) : 10 (-) : 12 | |
| Age at surgery (years) : Mean | (+) : 62.82 (-) : 56.44 | 0.116 |
| BMI (> 30) Obesity | (+) : 1 (-) : 3 | 0.409 |
| (< 18.5) Emaciation | (+) : 6 (-) : 11 | 0.347 |
| (18.5 ≤ BMI ≤ 30) Others | (+) : 21 (-) : 27 | |
| Diabetes mellitus [+] | (+) : 9 (-) : 6 | 0.083 |
| [-] | (+) : 19 (-) : 35 | |
| Smoke [+] | (+) : 10 (-) : 17 | 0.631 |
| [-] | (+) : 18 (-) : 24 | |
| Site Ischial | (+) : 13 (-) : 19 | 0.994 |
| Sacral | (+) : 5 (-) : 10 | 0.518 |
| Other | (+) : 10 (-) : 12 | |
| Reconstruction | | |
| Musculocutaneous (muscle) flap | (+) : 8 (-) : 3 | 0.018* |
| Others | (+) : 20 (-) : 38 | |
| Bacterial species detected in the wound | | |
| MRSA[+] | (+) : 11 (-) : 14 | 0.718 |
| [-] | (+) : 17 (-) : 27 | |
| Multiple bacterial species [+] | (+) : 14 (-) : 20 | 0.921 |
| [-] | (+) : 14 (-) : 21 | |
| Blood test [mean value] | | |
| Albumin (g/dl) | (+) : 2.99 (-) : 3.24 | 0.045* |
| CRP (mg/dl) | (+) : 3.57 (-) : 1.41 | 0.011* |
| WBC (×1000/μl) | (+) : 6.03 (-) : 6.65 | 0.280 |
| Hb (g/dl) | (+) : 10.85 (-) : 11.60 | 0.142 |
| Operative time (min) | (+) : 249.6 (-) : 157.8 | 0.003* |
| Ulcer size (major×minor axis cm ²) | (+) : 40.65 (-) : 24.20 | 0.080 |

*P < 0.05

BMI, body mass index ; CRP, C-reactive protein ; Hb, Hemoglobin ; MRSA, methicillin-resistant Staphylococcus aureus ; WBC, white blood cell

supports the notion that SSI is the cause of early wound dehiscence. MRSA has been reported to affect the incidence of SSI (14). In our study, however, MRSA and bacterial species counts were not risk factors for early wound dehiscence. We believe the reason for this result is that an appropriate antibiotic was selected and administered to our patients according to a preoperative bacterial test. Our results showed that the average operating time was relatively long and that the wound dehiscence rate was high. This may be due to a lack of experience, as we have not performed many pressure ulcer surgeries at our institution. The duration of antibiotic administration may also need to be examined (8, 15).

Bamba *et al.* (3) reported that long-term wound dehiscence was related to the ischial site, postoperative albumin level, osteomyelitis, perioperative blood transfusion, and operative time. Their study did not show a significant correlation between wound dehiscence incidence and ulcer size, similar to our findings. A limitation of this study as a result of its retrospective nature was that only the size of the surface of the ulcer, and not the depth and shape, was investigated due to a lack of records.

The complex shape and depth of the ulcer usually have profound effects on prolonging operative time. The presence of osteomyelitis also affects infection and surgery time. Our cases had a relatively high incidence of early wound dehiscence. We did not always perform MRI for all pressure ulcers with exposed bone (16). This high incidence may have been because of a lack of debridement. Furthermore, in cases where osteomyelitis was suspected preoperatively, it was possible that antibiotics should have been administered for a longer duration (15).

Various factors can influence operative time ; complex ulcer shapes, time-consuming debridement, the need for repositioning, and the skill of the surgeon often increase surgery time. To reduce the operative time, it may be effective to prepare the preoperative wound bed using negative pressure wound therapy (NPWT), select flaps that do not require repositioning, and reduce debridement time through hydrosurgery. NPWT has been reported to reduce chronic ulcer size quickly (17-20). Although ulcer area was not a risk factor that we investigated in our study, smaller ulcer areas result in faster debridement time. Furthermore, it has been reported that the hydrosurgery system is useful for reducing the time of debridement (21, 22).

There are several reports that low albumin levels are a risk factor for postoperative dehiscence of pressure ulcer surgery (6, 7). Correspondingly, low albumin levels are also a risk factor for SSI. Bamba *et al.* (3) reported that there was no correlation between postoperative complications and CRP. However, this study was not limited to the investigation of early wound dehiscence and therefore, may have differed from our results. Preoperative CRP and albumin levels have been reported to be risk factors for SSI (23, 24). Our results indicate that SSI is the likely cause of early wound dehiscence in pressure ulcer surgery. In the past, our facility has reported that CRP and albumin levels correlate negatively (25, 26). Therefore, we believe that low albumin levels may not only indicate low nutrition but may also be affected by CRP levels, which represent inflammation.

Chiu *et al.* (6) reported that there was no significant difference in pressure ulcer complications between different types of flaps. Although the presence of a musculocutaneous flap was a risk factor for early wound dehiscence in our results, the small number of cases and the lack of multivariate analysis may have affected the results. The pressure ulcers reconstructed with musculocutaneous flaps might have had deep wounds, which might have led to inadequate debridement and easy infection. However, since we did not examine the depth of the wounds, it is unclear whether this hypothesis is correct.

A limitation of this study is that a multivariate analysis was not possible due to the small number of patients. However, most of the risk factors for early wound dehiscence were consistent with those of SSI, and we believe that early wound dehiscence and SSI, under the appropriate postoperative restrictions, are the same complication.

CONCLUSION

The cause of early wound dehiscence was thought to be SSI. The incidence of early wound dehiscence by SSI was related to operative time, albumin levels, CRP levels, and the presence of a musculocutaneous flap. The prevention of SSI is important to prevent dehiscence in pressure ulcer surgery.

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