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Retrospective Study

Measurement of the combined flap thickness for reconstruction of decubitus ulcer using computed tomography

Combined flap in decubitus ulcer

Eun Chan Kim, Jeong Do Park, Syeo-Young Wee, Se-Young Kim

Abstract

BACKGROUND

Various reconstruction options have been introduced for the treatment of decubitus ulcers. A combined flap that takes advantage of both fasciocutaneous and muscle flaps has proven its efficacy for the reconstruction of decubitus ulcers in previous studies. However, no studies have been conducted on the measurement of this combined flap thickness. This is the first study to demonstrate the superiority of the combined flap by measuring its thickness using enhanced abdominal pelvic computed tomography (APCT).

AIM

The purpose of this study is to evaluate the the combined flap modality as a useful reconstruction option for decubitus ulcers using measurements obtained through APCT.

METHODS

Fifteen paraplegic patients who underwent combined flap surgery for the reconstruction of decubitus ulcers between March 2020 and December 2021 were included. The defect of skin component and muscle component was reconstructed separately. The inner gluteus muscle flap was split and manipulated to obliterate the dead space. The outer fasciocutaneous flap was transposed to cover the muscle flap and opening of decubitus ulcer. Subsequently, we performed enhanced APCT 3 wk and 6 mo postoperatively to measure the flap thickness.

RESULTS

The mean flap thickness was 32.85 ± 8.89 mm at 3 wk postoperatively and 29.27 ± 8.22 mm at 6 mo postoperatively. The flap thickness was maintained without major complications.

CONCLUSION

Although there was a significant decrease in flap thickness as measured by APCT, the combined flap provided sufficient padding and maintained its thickness even 6 mo after the reconstruction. No contour deformities, such as concavity or recurrence, were found. This suggests that the combined flap modality can be a useful reconstruction option for paraplegic patients with decubitus ulcers.

Key Words: Decubitus ulcer; Surgical flaps; Ischium; Trochanter; Computed tomography

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Core Tip: In this study, the authors investigated the use of combined fasciocutaneous and gluteus maximus muscle flaps in reconstructing grade IV decubitus ulcers in paraplegic patients. They employed radiological evaluation to measure flap thickness and found that the combined flap approach provided successful reconstructions with only minor complications. The study revealed a slight reduction in flap thickness over time, but it maintained adequate coverage. This combined flap method offers a valuable treatment option for challenging decubitus ulcers in paraplegic patients, addressing issues of flap thickness and recurrence.

INTRODUCTION

Reconstruction of decubitus ulcers is challenging due to the high rate of recurrence and complications. Surgical reconstruction is rarely required for grade I and II decubitus ulcers, which can typically be managed conservatively with proper nutrition, adequate positional changes, and dressings. However, in cases of grade III and IV decubitus ulcers, surgical reconstruction may be recommended. The selection of an appropriate

reconstruction option is a critical factor contributing to the procedure's success [1]. Various reconstruction methods have been utilized, including musculocutaneous, fasciocutaneous, and perforator flaps. Recently, fasciocutaneous and perforator flaps have gained popularity due to their lower donor site morbidity [2,3]. Nevertheless, their limited volume and bulk compared to muscle flaps may lead to recurrence due to inadequate padding. In cases of deep and wide decubitus ulcers, muscle flaps can provide sufficient padding to obliterate the dead space effectively.

However, there is currently no universally accepted gold standard for the reconstruction of decubitus ulcers, leading many surgeons to explore new methods. One such approach combines the advantages of a perforator-based fasciocutaneous flap and a muscle flap, which has shown promise in decubitus ulcer reconstruction [4-6]. However, no study has investigated whether flap thickness is maintained and whether adequate padding is provided in patients who undergo reconstruction using this combined flap. Therefore, the primary objective of our study was to measure the thickness of combined flap coverage in paraplegic patients with decubitus ulcers using radiological evaluation.

MATERIALS AND METHODS

Study design

This retrospective clinical study was conducted between March 2020 and December 2021 at Soonchunhyang University Gumi Hospital. Patients who received combined flap coverage for the reconstruction of grade IV decubitus ulcers on the ischial or trochanteric region were included. All patients with ischial or trochanteric sore underwent the same surgical procedure regardless of defect size due to the severity of the ulcer being grade IV and for problems of recurrence. The study received approval from the Institutional Review Board of the Soonchunhyang Medical Center Office of the Human Research Protection Program (IRB No. 2021-14) and was conducted in accordance with the principles of the Declaration of Helsinki. All patients provided written informed consent for the use and publication of their images. This study

included only patients who were in a paraplegic state; ambulatory patients were excluded. Patients with a history of gluteus maximus flap reconstruction were also excluded. After admission, all patients underwent thorough irrigation and surgical debridement of the necrotic tissue. Appropriate antibiotics were administered based on bone biopsy and wound culture results. Negative pressure wound therapy was employed for bed preparation. Preoperative enhanced abdominal pelvic computed tomography (APCT) was used to evaluate the patient's wound, and computed tomography was also used to identify the perforator of the gluteal region prior to surgery.

Surgical method

All reconstruction procedures were performed under general anesthesia with the patient in the prone position. The ulcer and bursa were stained with gentian violet ink and completely removed using Versajet (Smith-Nephew, Hull, UK) until healthy soft tissue was exposed. The protruded bone was removed using a rongeur and burr. After debridement, a perforator-based fasciocutaneous flap was designed, considering the defect size, location, and donor site closure. The fasciocutaneous flap was elevated with careful and meticulous perforator dissection and separated from the underlying gluteus maximus muscle. The gluteus maximus muscle was identified, and the incision line was designed on the muscle, depending on the size and location of the exposed bone defect. The gluteus maximus muscle was dissected parallel to the muscle fiber and split from its origin or insertion. After transposing the muscle flap, it was anchored to the surrounding fascia or periosteum. To prevent seroma and hematoma, drainage tubes were inserted under both the muscle and fasciocutaneous flaps. Subsequently, a perforator-based fasciocutaneous flap was transposed, rotated, or advanced to cover the muscle flap.

During the postoperative period, drainage tubes were removed after 10 days, and sutures were removed 3 wk post-surgery. The patient was maintained in the prone

position for 3–4 wk, and wheelchair mobility was encouraged 4 wk after the reconstruction.

Quantitative Evaluation of Flap Thickness Using Radiologic Examination

Enhanced APCT was used to measure the thickness of combined flap coverage. Preoperative CT examinations were performed the day after admission, and the first postoperative enhanced CT examination was conducted 3 wk after the reconstruction when the wound was stabilized. A second postoperative CT examination was performed in an outpatient clinic at 6 mo after the reconstruction, with a slice thickness of 5 mm. In the axial image slice of the preoperative CT scan, the deepest point at which the bone was exposed served as the reference point. Flap thickness was defined as the vertical distance from the reference point to the skin. Flap thickness was measured on an axial image slice of the postoperative CT image at the same level as the reference point. Flap thicknesses at 3 wk and 6 mo after the reconstruction were compared using digital calipers of the PACS image review software. All measurements were made by the first author using the same protocol mentioned above.

Statistical analysis

Statistical analyses were performed using SPSS software version 26¹ (IBM SPSS Statistics for Windows, version 26, IBM Corp., Armonk, N.Y., USA). The paired t-test was used to analyze the difference between flap thicknesses at 3 wk and 6 mo after the reconstruction.

RESULTS

A total of 15 patients (11 men and 4 women) underwent reconstruction using the gluteus maximus muscle flap and perforator-based fasciocutaneous combined flap.² The mean age of patients was 60.6 (range, 42–72 years). The mean follow-up period was 10.5 mo (range, 6–18 mo). Data on each patient, including age, sex, location, defect size, and flap type, are presented in Table 1. The defect size of the decubitus ulcer ranged from 16

cm² to 156 cm² with a mean value of 36cm², while the size of the muscle flaps ranged from 40 cm² to 150 cm² (mean 59cm²) , and the size of the fasciocutaneous flap ranged from 40 cm² to 90 cm² (mean 59cm²). Flap thickness measurements at 3 wk and 6 mo post-surgery using CT are shown in Table 2 and Figure 3. The mean flap thickness at 3 wk postoperatively was 32.85±8.89 mm, and at 6 mo postoperatively, it was 29.27±8.22 mm. A significant reduction in flap thickness was noted when comparing the 3 wk and 6 mo postoperative CT images. Notably, there were no cases of partial or total flap loss, with only two minor complications observed. One case of wound dehiscence occurred after the stitch-out process but resolved with wound revision, and another case of seroma was resolved with aspiration at the outpatient clinic.

DISCUSSION

The successful reconstruction of decubitus ulcers depends on various factors, including the patient's nutritional status, medical history, and postoperative care [7]. Among these factors, the selection of an appropriate flap type is crucial for procedure success [1]. Recently, fasciocutaneous and perforator flaps have gained popularity for decubitus ulcer reconstruction due to their advantage in preserving muscle function and minimizing donor site morbidity. However, their relatively thin nature may not be sufficient to obliterate large dead spaces, making muscle flaps an ideal option in such cases [8,9,10,11]. The gluteus maximus muscle is a preferred reconstructive option for decubitus ulcers as it provides adequate padding to cover exposed bone [12].

In our study, we addressed the challenge of a small opening relative to a large inner pocket size, resulting in a discrepancy between the sizes of the skin and muscle components requiring reconstruction. To overcome this issue, we employed a combined flap approach to separately cover defects of different sizes in skin and muscle components while harnessing the advantages of both fasciocutaneous and muscle flaps. The inner gluteus muscle flap was manipulated to provide the desired shape and volume to obliterate the dead space effectively. The outer fasciocutaneous flap was either rotated or transposed to cover the muscle flap and the decubitus ulcer opening.

This combination of fasciocutaneous and gluteus maximus muscle flaps enabled us to minimize the wide dead space, providing a double-layer thickness.

Several reports have explored the treatment of ischial ulcers using a combination of fasciocutaneous and gluteus maximus muscle flaps. For example, Ku *et al* treated ischial ulcers by combining the gluteus maximus muscle flap with an inferior gluteal artery perforator fasciocutaneous flap, reporting a lower recurrence rate (8-64%) compared to ischial ulcers treated with other muscle flaps or fasciocutaneous flaps [4]. Similarly, Borgognone *et al* treated ischial ulcers with a combination of the gluteus maximus muscle flap and a rhomboid-shaped fasciocutaneous flap, highlighting the advantage of preserving tissue from hypoxic damage by independently supplying blood to each flap [14]. However, previous reports assessed the combined flap's utility primarily based on recurrence during the post-reconstruction follow-up period and did not provide an adequate evaluation of flap thickness. In contrast, our study measured flap thickness using CT scans.

In our cohort, we observed no major complications following combined flap coverage, and patients experienced successful reconstructions without recurrence during the follow-up period. To ascertain whether flap thickness was maintained, we compared CT examinations conducted at 3 wk and 6 mo postoperatively. On average, 88.98% of the flap thickness was retained after 6 mo, with a slight decrease observed in the statistical analysis.

3 Our study has some limitations. First, the sample size is relatively small. Second, flap thickness was indirectly assessed using CT scans rather than intraoperative measurements, which may introduce measurement errors. Lastly, the 6-month follow-up period may be insufficient considering the typical recurrence period of decubitus ulcers, which is approximately one year [15]. Larger studies with longer follow-up periods are warranted to further explore the combined flap's effectiveness.

It is essential to address the reasons for changes in flap thickness in our cohort. First, as time passed, subsiding soft tissue swelling may have contributed to a reduction in flap thickness. Second, the supine position during the APCT scan may have affected flap

thickness. Third, atrophic changes due to the interruption of the reflex arc or ischemia cannot be ruled out. Nevertheless, we did not observe any clinical findings, such as concavity of the flap surface.

CONCLUSION

In conclusion, our study demonstrated successful reconstruction of grade IV decubitus ulcers in paraplegic patients using a combination of fasciocutaneous and gluteus maximus muscle flaps. We employed enhanced APCT to measure flap thickness and observed a slight but statistically significant reduction in flap thickness. Importantly, patients achieved successful reconstructions without major complications. Thus, the combined flap method presents a valuable treatment option for decubitus ulcers in paraplegic patients.

ARTICLE HIGHLIGHTS

Research background

Decubitus ulcers, especially grade III and IV, pose significant challenges in reconstruction due to high recurrence rates. Surgical options, including muscle flaps and fasciocutaneous flaps, have been explored, but there is no universally accepted gold standard.

Research motivation

This study aims to assess the thickness of combined fasciocutaneous and gluteus maximus muscle flaps used in paraplegic patients for grade IV decubitus ulcer reconstruction, addressing the need for effective treatments with minimal complications.

Research objectives

The primary objective is to measure the flap thickness using radiological evaluation in paraplegic patients who underwent combined flap reconstruction for severe decubitus ulcers.

Research methods

A retrospective clinical study was conducted, including paraplegic patients who received combined flap coverage for grade IV decubitus ulcers. Flap thickness was measured using enhanced abdominal pelvic computed tomography (APCT) at 3 wk and 6 mo post-surgery.

Research results

The study demonstrated successful reconstruction without major complications. Flap thickness decreased slightly but significantly between 3 wk and 6 mo post-surgery, with an average retention of 88.98%.

Research conclusions

Combined fasciocutaneous and gluteus maximus muscle flaps offer an effective option for grade IV decubitus ulcer reconstruction in paraplegic patients, with the potential to maintain flap thickness over time.

Research perspectives

Larger studies with longer follow-up periods are needed to further assess the effectiveness of combined flaps. Additionally, exploring factors influencing flap thickness changes can enhance our understanding of long-term outcomes in decubitus ulcer reconstruction.

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