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Comparison between artificial dermis with split-thickness skin graft and full-thickness skin graft for reconstruction of joint-involved burn wounds: A retrospective review from a tertiary burn centre

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Abstract

We aimed to compare the scar quality and recovery rate of joint activity for patients with joint-involved burn injuries receiving either artificial dermis (AD) with split-thickness skin graft (STSG) or full-thickness skin graft (FTSG) for reconstruction. The primary outcomes were %skin graft (SG) take. Secondary outcomes included complications such as the infection rate and donor site morbidity, 12-month scar quality evaluated using the Vancouver scar scale (VSS), recovery rate of joint activity and incidence of scar contracture requiring further revision. Twenty-eight patients between 1 August 2021, and 1 August 2023, were enrolled. Twelve patients received AD-STSG while the other 16 patients underwent FTSG for reconstruction. The median %SG take was 95.0% (interquartile range [IQR] 6.3%) and 96.0% (IQR 10.0%) for the AD-STSG and FTSG groups ($p = 0.71$). The FTSG group had significantly better 12-month scar quality (median VSS 4.0 [IQR 1.3] vs. 6.0 [IQR1.5], $p < 0.01$) and recovery rate of joint activity (median 82.5% [IQT 15.0%] vs. 70.0% [IQR 7.5%], $p < 0.01$) compared with AD-STSG group. However, two patients in the FTSG group (12.5%) suffered partial wound dehiscence of the donor site, whereas no patients experienced donor site morbidity in the AD-STSG group ($p = 0.49$). The incidence of scar contracture requiring further revision was 25.0% (3/12) in the AD-STSG group and 12.5% (2/16) in the FTSG group ($p = 0.62$). In conclusion, AD-STSG could be an alternative treatment over FTSG for larger joint-involved burn wounds (>200 cm^2) owing to lesser donor site morbidity with admissible cosmetic outcomes and functional recovery.

KEYWORDS

artificial dermis, burn, full-thickness skin graft, joint, split-thickness skin graft

List of Abbreviations: AD, artificial dermis; AD-STSG, artificial dermis combined with split-thickness skin graft; FTSG, full-thickness skin graft; IQR, interquartile range; ROM, range of motion; SG, skin graft; STSG, split-thickness skin graft; VSS, Vancouver scar scale.

Key Messages

- This study investigated the outcomes for patients with joint-involved burn injuries receiving either artificial dermis (AD) with split-thickness skin graft (STSG) or full-thickness skin graft (FTSG) for reconstruction.
- We retrospectively reviewed a total of 28 patients from 1 August 2021, to 1 August 2023, in a tertiary referral burn centre in southern Taiwan.
- To the best of our knowledge, this study compared the clinical outcomes of scar quality and functional recovery between patients receiving either FTSG or AD with STSG for joint-involved burn wounds.
- Our results are promising and provide important relevant clinical information.
- Thus, we suggest that this article has potential interesting for your consideration.

1 | INTRODUCTION

Skin graft (SG) plays an important role during the reconstruction of large burn injuries by rapidly covering skin defects and preventing wound contraction.[1] For joint-involved burn wounds, in consideration of functional recovery, a full-thickness skin graft (FTSG) is better than a split-thickness skin graft (STSG) for lesser secondary contractures.[2] However, the major disadvantage of FTSG is the limitation of available donor sites.[3]

Artificial dermis (AD) has gained increased popularity in recent burn wound reconstruction practices.[4–6] It has served as a template for dermal regeneration with the advantages of reducing wound pain and risk of wound infection, facilitating the wound healing process and improving scar quality.[7–9] It is believed to have therapeutic effects over prevention of hypertrophic scar and joint contractures, which have been the major considerations during burn wound reconstructions.[10,11]

Several studies have used AD combined with STSG (AD-STSG) for the reconstruction of burn injuries over functional parts such as hands and feet.[12–14] However, few studies have evaluated the scar quality and recovery rate of joint activity between AD-STSG and FTSG. Therefore, we compared the cosmetic and functional outcomes of AD-TSG and FTSG for reconstructing joint-involved burn wounds in the present study.

2 | MATERIALS AND METHODS

Patients with joint-involved burn wounds receiving reconstruction by either AD-STSG or FTSG between 1 August 2021, and 1 August 2023, were retrospectively reviewed. The medical records and photographs of all the patients were analysed. The data collected included demographic information (age and sex), depth and size of burn wounds, site of involving joint areas, presence of infection before skin grafting, operations, types of artificial dermis used and the time interval between applying artificial dermis and performing skin grafting.

The primary outcomes were %SG take. Secondary outcomes included complications such as infection rate and donor site morbidity, 12-month scar quality evaluated using the Vancouver scar scale (VSS), recovery rate of joint range of motion (ROM) (%) (degree of ROM for the injured joint/normal degree of ROM of the joint $\times$ 100%) and incidence of scar contracture requiring further revision. All patients were followed-up for at least a year. The study excluded patients who received additional adjuvant therapy (topical growth factors or hyperbaric oxygen therapy), lost to follow-up or had missing data. The study was approved by the institutional review board (IRB No. 202400234B0).

2.1 | Statistical analysis

Statistical analysis was performed using SPSS version 21.0 (IBM Corporation, Armonk, NY, USA). Categorical data were expressed as frequency and percentage and were analysed using the chi-square or Fisher's exact test, while continuous data were expressed as the median and interquartile range (IQR) and were analysed using the Mann–Whitney U test. Differences with $p < 0.05$ were considered to be statistically significant.

3 | RESULTS

Thirty-five patients with joint-involved burn injuries were initially included. Patients receiving topical growth factors ($n = 1$), hyperbaric oxygen therapy ($n = 2$), lost to follow-up ($n = 2$) and those with missing data ($n = 2$)

TABLE 1 Patient characteristics.

	AD-STSG[a] ($n = 12$)	FTSG[b] ($n = 16$)	p value
Age (years), median (IQR)	50.5 (14.8)	51.0 (31.3)	0.984
Sex, n (%)			0.691
Male	8 (66.7)	12 (75.0)	
Female	4 (33.3)	4 (25.0)	
Wound depth, n (%)			1.0
Partial thickness (superficial)	1 (8.3)	1 (6.3)	
Partial thickness (deep)	6 (50.0)	7 (43.8)	
Full thickness	5 (41.7)	8 (50.0)	
Wound size (cm^2), median (IQR)	112.5 (71.3)	67.5 (76.3)	0.049
Joint involvement, n (%)			
Elbow	5 (41.7)	3 (18.8)	0.231
Wrist	2 (16.7)	3 (18.8)	1.0
Metacarpophalangeal (MCP) joint	0 (0.0)	5 (31.3)	0.053
Interphalangeal (IP) joint	1 (8.3)	1 (6.3)	1.0
Knee	0 (0.0)	2 (12.5)	0.492
Ankle	4 (33.3)	1 (6.3)	0.133
Metatarsophalangeal (MTP) joint	0 (0.0)	1 (6.3)	1.0
Wound infection before skin graft, n (%)	1 (8.3)	4 (23.5)	0.355

[a]AD-STSG—artificial dermis with split-thickness skin graft.
[b]FTSG—full-thickness skin graft.

TABLE 2 Characteristics of artificial dermis (AD).

AD type, n (%)	
Terudermis®	10 (83.3)
NovoSorb® BTM	2 (16.7)
AD size (cm^2), median (IQR)	75.0 (42.5)
Time from AD to skin graft (days), median (IQR)	14.0 (6.0)

were excluded. Eventually, 28 patients (20 males, 8 females; median age 51.0 years [IQR 20.5]) were enrolled in this study for evaluation (Table 1). Twelve patients received AD-STSG while the remaining 16 patients underwent FTSG for reconstruction. Aside from the significantly larger size of defects observed in patients in the AD-STSG group, no other significant differences in age, sex, wound depth, areas of joint involvement and presence of wound infection before skin graft were noticed among patients in both groups.

In the AD-STSG group, 10 patients underwent artificial dermal graft with Terudermis® and the other 2 with NovoSorb® BTM (Table 2). The median AD size was 75.0 cm^2 (IQR 42.5), and the median time interval from applying AD to skin graft was 14.0 days (IQR 6.0).

The median %SG take was 95.0% (IQR 6.3%) for the AD-STSG group and 96.0% (IQR 10.0%) for the FTSG group ($p = 0.71$) (Table 3). No postoperative skin graft infections were observed in either group. Two patients in the FTSG group (12.5%) with larger SG size (210 and 240 cm^2, respectively) developed partial wound dehiscence owing to tension over donor wounds during skin closure, whereas no donor site morbidity was observed in the AD-STSG group ($p = 0.49$). The median VSS for 12-month scar quality was 6.0 (IQR 1.5) and 4.0 (IQR 1.3) for the AD-STSG and FTSG groups ($p < 0.01$), respectively. The median recovery rate of joint range of motion was 70.0% (IQR 7.5%) and 82.5% (IQR 15.0%) in the AD-STSG and FTSG groups ($p < 0.01$), respectively. The incidence of scar contracture requiring further revision was 25.0% (3/12) and 12.5% (2/16) in the AD-STSG and FTSG groups ($p = 0.62$), respectively.

4 | CASE PRESENTATION

4.1 | Case 1: FTSG

A 33-year-old male with no underlying health conditions sustained bilateral lower extremity flame burns

TABLE 3 Outcomes.

	AD-STSG[a] ($n = 12$)	FTSG[b] ($n = 16$)	p value
%Skin graft (SG) take, median (IQR)	95.0 (6.3)	96.0 (10.0)	0.711
Postoperative SG infection, *n* (%)	0 (0.0)	0 (0.0)	1.0
Donor site morbidity, *n* (%)	0 (0.0)	2 (12.5)	0.492
Vancouver scar scale (12-month), median (IQR)	6.0 (1.5)	4.0 (1.3)	<0.01
Recovery of joint activity (%), median (IQR)	70.0 (7.5)	82.5 (15.0)	<0.01
Scar contracture requiring further revision, *n* (%)	3 (25.0)	2 (12.5)	0.624

[a]AD-STSG—artificial dermis with split-thickness skin graft.
[b]FTSG—full-thickness skin graft.

FIGURE 1 (Left) A 33-year-old male with no underlying health conditions sustained flame burns over bilateral lower limb. After several times of debridement, FTSGs were used for reconstruction of skin defect over bilateral popliteal fossa. (Right) After a year, the scar was smooth and soft with sparse areas of hyperpigmentation.

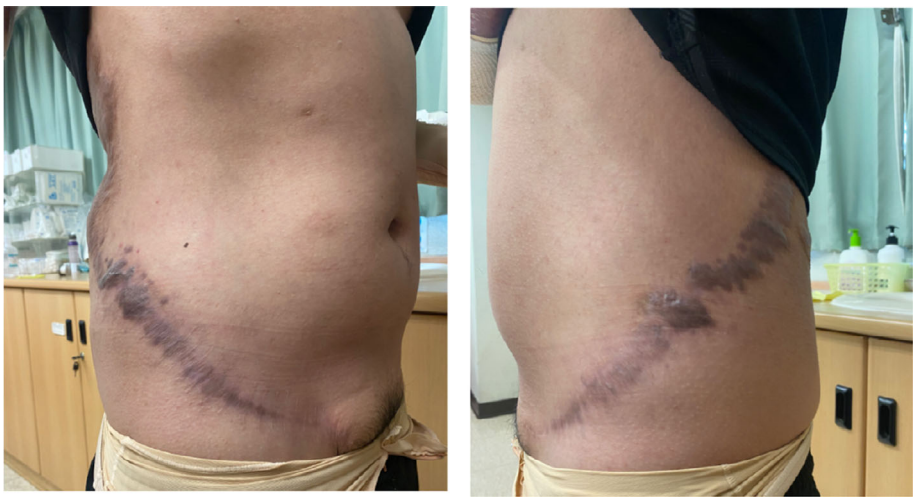

FIGURE 2 (Case 1) Bilateral donor wound developed hypertrophic scar with hyperpigmentation due to partial wound dehiscence and prolonged healing time (more than a month).

(Figure 1). After several debridement procedures, FTSGs from the bilateral groin area were used to reconstruct the skin defects (240 cm^2) over bilateral popliteal fossa. After a year, the scar was smooth and soft with sparse areas of hyperpigmentation. Besides, recovery of the knee joint extension was also good (>90%) (Videos S1 and S2).

FIGURE 3 (Left) A 44-year-old male with no underlying health conditions sustained contact thermal burns over his right upper limb. After serial debridements, we applied AD (Terudermis®) and then STSG for the elbow wound. (Middle and right) The scar was smooth and soft with certain degree of hyperpigmentation after a year.

However, the patient had partial wound dehiscence over the bilateral donor site with prolonged healing time (more than a month) and developed scar hypertrophy (Figure 2).

4.2 | Case 2: AD-STSG

A 44-year-old male with no underlying health conditions sustained contact thermal burns over his right upper limb (Figure 3). After serial debridement procedures, we applied AD (Terudermis®) to the elbow wound. Skin grafting was performed subsequently after AD take. The scar was smooth and soft with slight hyperpigmentation after a year. Recovery of elbow flexion was also acceptable (approximately 80%) (Videos S3 and S4).

4.3 | Case 3: AD-STSG

A 33-year-old female with no underlying health conditions suffered from contact thermal burns over her right upper limb (Figure 4). We applied AD (Terudermis®) to the elbow joint region. After a week, we performed skin grafting over the whole upper limb defect. After a year, the scar appearance on the AD site was much more even and smoother than in areas treated with STSG alone, and the elbow joint ROM achieved nearly full recovery (>90%) (Video S5).

FIGURE 4 A 33-year-old female with no underlying health conditions suffered contact thermal burns over her right upper limb. (Upper) We used AD (Terudermis®) over the elbow joint region and performed skin grafting over the whole upper limb defect after a week. (Lower) Scar appearance over AD site (as area depicted by white line) was more even and smoother than area with STSG alone after a year.

5 | DISCUSSION

This study showed that the cosmetic and functional outcomes of FTSG were superior to AD-STSG for reconstructing joint-involved burn wounds. However, donor site morbidity was observed in the FTSG group among patients with larger SG size (>200 cm^2). Therefore, we proposed that AD-STSG is a reasonable choice for reconstructing massive burn wounds with joint involvement.

The results showed that both the FTSG and AD-STSG had excellent median %SG take (96.0 [IQR 10.0] vs. 95.0 [IQR 6.3]; $p = 0.71$), and they were similar to that reported in other studies.[15–17] Furthermore, the median VSS of FTSG was significantly lower than that of AD-STSG (4.0 [IQR 1.3] vs. 6.0 [IQR 1.5]; $p < 0.01$), indicating better scar quality. In our study, patients who underwent FTSG reconstruction mostly possessed scars with normal vascularity, a certain degree of hyperpigmentation, normal or supple pliability and flat appearances. On the contrary, most patients in the AD-STSG group had scars with normal to pink vascularity, hypo- or hyperpigmentation, supple to yielding pliability and approximately 0–2 mm in height, which were similar to the findings from other studies.[13,14,18,19]

For the median recovery rate of joint activity, the FTSG group results were better than those of the AD-STSG group (82.5% [IQR 15.0%] vs. 70.0% [IQR 7.5%]; $p < 0.01$). The functional recovery in the AD-STSG group seemed comparable to finding from other studies,[13,20–24] with most of our patients achieving acceptable recovery rates of joint ROM (>70%). Besides, no significant differences were observed in the rates of patients with scar contracture who needed secondary revision between the FTSG and AD-STSG groups (12.5% vs. 25.0%, $p = 0.62$).

Accordingly, with better cosmetic and functional outcomes in our study, FTSG seemed to be superior to AD-STSG for reconstructing joint-involved burn wounds. Nevertheless, two of our patients in the FTSG group with larger skin defects (both >200 cm^2) experienced partial donor wound dehiscence, prolonged wound healing time (more than a month) and scar hypertrophy (Figure 2). The main reason for such donor site morbidity was owing to the relatively large size of harvested SG that caused more tension over the skin margins of donor wounds.[25–27] By contrast, AD-STSG did not cause donor site morbidity in our study. Therefore, for larger burn wounds (>200 cm^2) around joint areas, AD-STSG could be an alternative treatment over FTSG owing to lesser donor site morbidity and admissible functional outcomes.

Nonetheless, there were some limitations to our study, the first of which was its retrospective design with missing data and the inability to randomize between the two groups. Second, the sample size was relatively small. Third, different areas of involved joints were analysed together. Fourth, subjective components during scar evaluation were inevitable. Finally, previous studies regarding AD-STSG were mostly case-based, single-centre design, leading to difficulty in comprehensible comparisons of outcomes.

6 | CONCLUSION

The cosmetic and functional outcomes FTSG are superior to those of AD-STSG for the reconstruction of joint-involved burn wounds. Nevertheless, no significant differences in incidence of scar contracture requiring secondary revision were observed in the AD-STSG group compared with the FTSG group. Moreover, AD-STSG could be an alternative treatment over FTSG for larger joint-involved burn wounds (>200 cm^2) owing to lesser donor site morbidity with admissible cosmetic outcomes and functional recovery.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

Data available on request from the authors.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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