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Patient-reported scar quality of donor-sites following split-skin grafting in burn patients: Long-term results of a prospective cohort study

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ABSTRACT

Background: Skin grafting is the current gold standard for treatment of deeper burns. How patients appraise the donor-site scar is poorly investigated. The aim of this study was to evaluate long-term patient-reported quality of donor-site scars after split skin grafting and identify possible predictors.
Methods: A prospective cohort study was conducted. Patients were included in a Dutch burn centre during one year. Patient-reported quality of donor-site scars and their worst burn scar was assessed at 12 months using the Patient and Observer Scar Assessment Scale (POSAS). Mixed model analyses were used to identify predictors of scar quality.
Results: This study included 115 donor-site scars of 72 patients with a mean TBSA burned of 11.2%. The vast majority of the donor-site scars (84.4%) were rated as having at least minor differences with normal skin (POSAS item score $\geq$2) on one or more scar characteristics and the overall opinion on 80.9% of the donor-site scars was that they deviated from normal skin 12 months after surgery. The overall opinion on the donor-site scar was 3.2 ± 2.1 vs. 5.1 ± 2.4 on the burn scar. A younger age, female gender, a darker skin type, and location on the lower leg were predictors of reduced donor-site scar quality. In addition, time to re-epithelization was associated with scar quality.
Conclusion: This study provided new insights in long-term scar quality of donor-sites. Donor-site scars differed from normal skin in a large part of the population 12 months after surgery. Results of this study can be used to inform patients on the long-term outcomes of their scars and to tailor preventive or therapeutic treatment options.

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1. Background

In present day burn care, excision and skin grafting is the cornerstone in the treatment of deeper burns to facilitate wound healing and provide a good functional and aesthetic scar outcome [1–3].

On the one hand, skin grafting offers an important therapeutic option in the treatment of burn wounds. On the other hand, donor-sites that remain after skin grafting form scars, which may heal aesthetically displeasing with noticeable depigmentation and hypertrophy [4–6]. Scars of the donor-sites are rectangular, linear-shaped and commonly placed on the patients' thigh, arms or back. Patients just have to accept this extra scar whilst it may have an impact on their quality of life [4,7].

The incorporation of patients' values and opinions is endorsed to ensure high-quality patient-centred care [8–10]. Although scar quality is one of the most important outcomes in burn surgery today, there is no evidence to support therapeutic decision-making regarding skin grafting and expected donor-site morbidity. In massive burn injuries, donor-site scarring might be of limited importance. However, when treating smaller injuries, other treatment options might be considered if significant distress for the patient is expected after surgery.

Clinical observations at our institution have shown that caregivers seem to underestimate the impact of donor-site scarring on patients [11]. Therefore, the main aim of this study was to evaluate long-term patient-reported scar quality of donor-sites one-year after surgery. Our secondary aim was to identify factors related to patient-reported scar quality of donor-sites in burn patients.

2. Methods

2.1. Design and participants

The present study is part of an observational prospective cohort study. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines were adhered to in this study and manuscript. Patients of all ages who underwent excision and split-skin grafting for a burn wound between February 2017 and February 2018 in the burn centre of the Maasstad Hospital in Rotterdam were asked to participate. Patients were included if they were able to comply with the study protocol and signed informed consent. A maximum of 3 donor sites per patient were included. The study was conducted according to the principles of the Declaration of Helsinki and Dutch laws and approved by the regional Ethics Committee (reference number L2016119).

2.2. Treatment

Skin grafts were harvested at a depth of 0.2 mm (0.007 inch) with an electric Aesculap® dermatome. Adrenaline soaked gauzes were placed on the wounds immediately after grafting to reduce blood loss. Afterwards, donor site wounds were covered with an alginate dressing, cotton wool and elastic bandages, which were removed 2 weeks after surgery.

2.3. Scar quality assessment

Scar quality was assessed at 12 months after burn in the outpatient clinic. The patient part of the Patient and Observer Scar Assessment Scale (POSAS) version 2.0 was used to assess the scar quality of their donor sites and of the burn scar that they indicated as most severe. The patient scored the items pain, itch, color, pliability, thickness, and relief. All items were scored on a 10-point rating scale. A lower score correlates with a better scar, where 1 resembles 'normal skin' and 10 resembles 'very different from normal skin'. The mean POSAS score was calculated by summing up the six item scores and dividing this by 6. Furthermore, patients were asked to give their overall opinion of the scar on a scale from 1 (best scar imaginable) to 10 (worst scar imaginable). The outcomes of the POSAS were divided into 3 categories: (1) low score, no differences with normal skin: POSAS item score 1; (2) intermediate scores, minor differences with normal skin: POSAS item score 2 or 3; (3) high scores, major differences with normal skin: POSAS item score $\geq$ 4. These cut-off points are arbitrary in the absence of commonly used cut-off points and in the absence of a minimal important change analysis of the POSAS [12].

2.4. Other study parameters

Other study parameters were documented during admission, surgery and outpatient visits. These were patient characteristics: age at surgery, gender, skin type, diabetes yes/no and smoking yes/no. Registered clinical characteristics were burn-related: % total burned body surface area (TBSA), % TBSA excised, length of stay, POSAS of the burn scar, and donor site-related: location on the body, location in relation to the burn wound, surface area, >2 weeks to re-epithelization, application of pressure garment and application of silicone gel.

2.5. Statistical analysis

We compared the main baseline characteristics of participants and nonparticipants to determine if there were any relevant differences between the groups using the independent t-test or Mann Whitney U tests (for continuous variables) and chi^2 test (for categorical variables). Descriptive statistics were used to assess long-term scar quality and characterize patients with low and high POSAS scores. Pearson statistics were used to identify the correlation between patient rated POSAS scores of the donor-site scar and burn scar (i.e. recipient site scars).

Univariable and multivariable mixed model analyses were performed to determine the predictive value of patient-, clinical- and donor-site-related factors for the mean POSAS score and mean overall opinion of the POSAS. Mixed model analysis was used to take into account the dependency of the multiple observations within the participants if more than one donor site per patient was included. Factors with univariable $p < 0.20$ were selected for multivariable analyses. A backward selection procedure was used to obtain the final models for the outcomes, in which only variables with $p < 0.10$ were selected. IBM SPSS Statistics 23 and STATA version 14 were used for the analysis.

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3. Results

A total of 114 patients were screened for eligibility during the study period. Of these, 106 patients were eligible to participate and 80 patients signed informed consent. At 12 months after surgery, 7 patients were lost to follow-up and 1 patient deceased, resulting in a total study population of 72 patients with 115 donor site scars. Patients included in the analysis had a mean age of 37.4 ± 23.0 years, 23.8% were aged ≤16 years, and most were male (65.3%) (Table 1). Most burns were caused by flames (51.4%). Mean %TBSA burned was 11.2 ± 11.4, mean length of hospital stay was 24.8 ± 23.2 days, and most participants had only 1 donor site (62.6%). Most donor-sites were placed on the patients' thigh (76.5%).

3.1. *Donor site scar quality*

The mean POSAS score (based on the six POSAS items) was 1.9 ± 1.2 (range 1.0–7.2) at one-year after surgery. Eighteen patients (25.0%) scored all six items as 1, indicating that their donor site scar did not deviate from normal skin (all had 1 donor site scar). These patients had a mean age of 43.1 ± 24.6 years and most (64.3%) were male. Thus, for the other donor-site scars (n = 97, 84.3%), patients reported at least minor differences (i.e. POSAS item score ≥2) on one or more scar characteristics. Six patients (8.0%) with a total of 8 donor sites (6.1%) reported a relatively high POSAS score (i.e. POSAS item score ≥4) for all POSAS items). These patients had a mean age of 29.7 ± 23.9 years and most (87.5%) were female.

The item 'color' was appreciated worst; for 41% of the scars, major differences compared to normal skin were reported and for 43% of the scars minor differences were reported (Fig. 1). For the scar characteristics itch, pliability, thickness and relief 8–12% of the donor site scars were rated with high scores (POSAS item score ≥4), while 73–88% were rated with no differences compared to normal skin (POSAS item score = 1). The lowest ratings were for the item pain; 97% of the scars were rated as 'no difference to normal skin', resulting in a mean score of 1.1 ± 0.6 (Fig. 1).

Patients' mean overall opinion of their donor site scars was 3.2 ± 2.2 (range 1–10) (Fig. 2). Twenty-two scars (19%, in 16 patients) were rated as 1 (i.e. 'best scar imaginable'). These patients had a mean age of 38.6 ± 24.6 years and most of these patients were male (81.3%). Thus, for all other scars (80.9%) at least minor dissatisfaction with the scar was reported. For 40 scars, 27 patients reported a relatively poor overall opinion (i.e. POSAS score ≥4). These patients had a mean age of 31.3 ± 21.3 years and 47.5% were male. In total, two patients rated 4 scars as 10 (i.e. 'worst scar imaginable). These patients were both female and had a mean age of 35.5 ± 13.4 years. Fig. 2 shows the mean and standard deviation of the POSAS item scores of the donor-site scar and most severe burn scar (as indicated by the patient). The items 'pain' (1.1 ± 0.7 vs 1.9 ± 1.8), 'itch' (1.6 ± 1.7 vs 2.7 ± 2.3), 'color' (3.5 ± 2.1 vs. 5.2 ± 2.4), and 'overall opinion' (3.2 ± 2.1 vs. 5.1 ± 2.4) items differed least. The items 'pliability' (1.9 ± 2.0 vs. 4.2 ± 2.6), 'thickness'

Table 1 – Patient demographics and clinical data.

Patient characteristics	No. of patients (n = 72)
Age, mean (SD, range)	37.43 (23.0, 0–84)
Gender: Male, n(%)	47 (65.3%)
Fitzpatrick skin type	
I	12 (10.4%)
II	65 (56.5%)
III	12 (10.4%)
IV	18 (15.7%)
V	7 (6.1%)
VI	1 (0.9%)
Diabetes, n(%)	6 (5.2%)
Smoking, n(%)	35 (30.4%)
Clinical characteristics	
Burn aetiology	
Flame	37 (51.4%)
Scald	18 (25%)
Other	17 (23.6%)
%TBSA burned, mean (SD, range)	11.2 (11.4, 0.1–55)
%TBSA excised, mean (SD, range)	6.2 (7.1, 0.1–50)
Length of stay (days), mean (SD)	24.8 (23.2)
Donor site characteristics	**No. of Donor sites (n = 115)**
Location, n (%)	
Upper back	1 (0.9%)
Upper arm	12 (10.4%)
Lower arm	1 (0.9%)
Thigh	88 (76.5%)
Lower leg	13 (11.3%)
Same limb as burn wound, n (%)	56 (48.7%)
Adjacent to burn wound, n (%)	39 (39%)
Surface (cm^2), mean (SD)	167.5 (173.4)
Time to re-epithelization (>2 weeks), n (%)	28 (24.3%)
Wound infection, n (%)	8 (7.0%)
>1 time harvested, n (%)	3 (2.6%)
Application of pressure garment, n (%)	2 (1.7%)
Application of silicone gel, n (%)	19 (17.3%)

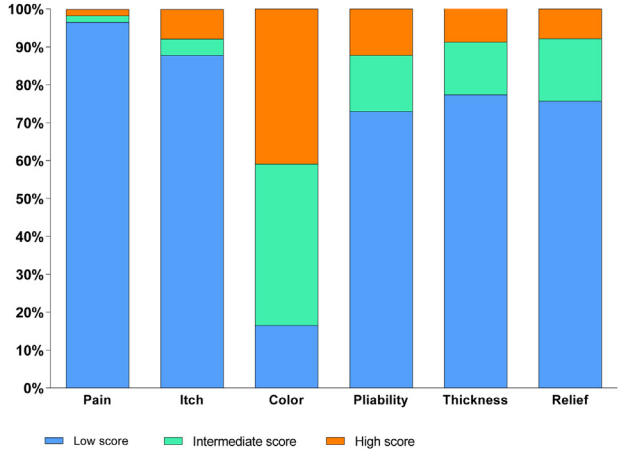

Fig. 1 – Proportion of donor sites for which patients scored low, intermediate, and high scores for scar-related problems on items of the patient part of the POSAS at 12 months after surgery. Low scores, no differences with normal skin; POSAS item score 1; intermediate scores, minor differences with normal skin: POSAS item score 2 or 3; high scores, major differences with normal skin: POSAS item score ≥4.

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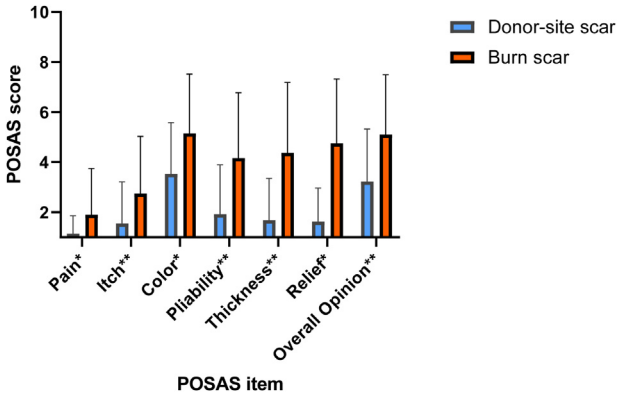

Fig. 2 – Patient reported POSAS scores of their donor-site and burn scar 12 months after surgery. A lower POSAS score correlates with a better scar; a score of 10 reflects the worst imaginable scar. *ICC < 0.3 (very low), **ICC 0.3–0.5 (low).

(1.7 ± 1.7 vs. 4.4 ± 2.8), and 'relief' (1.6 ± 1.3 vs 4.8 ± 2.6) differed most. All items had a very low or low ICC (Pearson's r < 0.30).

3.2. *Predictors of long-term donor-site scar quality*

The results of univariable and multivariable mixed model analysis are shown in Tables 2 and 3 respectively. In the final model, a higher age was associated with a better donor-site scar quality (i.e. a lower mean POSAS score (r = −0.01, SE = 0.01; p = 0.046)). Female gender (r = 0.76, SE = 0.27; p = 0.004), a higher Fitzpatrick skin type (r = 0.27, SE = 0.13,; p = 0.12) and time to re-epithelization exceeding 2 weeks (r = 0.66, SE = 0.26; p = 0.016) were associated with a poorer scar quality (i.e. higher mean POSAS score).

For the overall opinion, a higher age was associated with a better score (i.e. lower POSAS score (r = 0.02, SE = 0.01; p = 0.045). Female gender (r = 1.40, SE = 0.48; p = 0.045), location on the lower leg (r = 0.77, SE = 0.43; p = 0.077) and time to re-epithelization exceeding 2 weeks (r = 0.79, SE = 0.39; p = 0.044) were associated with a poorer overall opinion on the donor-site scar. None of the clinical characteristics were associated with patient-reported donor-site scar quality at 12 months (Table 2).

4. Discussion

This prospective cohort study assessed patient-reported quality of donorsite scars in a burn population one year after surgery. The majority of the scars (84.4%) were rated as having at least minor differences with normal skin (POSAS item score ≥2) on one or more scar characteristics. The overall opinion on the majority of the donor-site scars (80.9%) was that they deviated from normal skin.

The overall opinion of patients on their donor-site scar differed less than 2 points (POSAS 1–10 point scale) and patient-reported quality of burn scars and donor-site scars

Table 2 – Univariable mixed model analysis of predictors of long-term donor-site scar quality.

	Mean 6 item POSAS score			Overall opinion score		
Patient characteristics	R coefficient	SE	p-value	R coefficient	SE	p-value
Age (years)	−0.01	0.01	0.114	−0.02	0.01	0.158
Female gender	0.78	0.29	**0.008**	1.28	0.50	**0.010**
Fitzpatrick skin type	0.27	0.13	**0.042**	0.35	0.23	0.119
Diabetes	−0.38	0.63	0.554	0.43	1.09	0.694
Smoking	−0.58	0.31	0.061	−0.83	0.53	0.117
Clinical characteristics						
%TBSA burned	0.00	0.01	0.824	0.01	0.03	0.908
%TBSA excised	−0.01	0.02	0.526	−0.02	0.04	0.537
Total no. donor-sites	−0.18	0.35	0.604	0.34	0.60	0.569
Length of stay	0.01	0.01	0.695	0.01	0.01	0.496
Donor site characteristics						
Location - Body part						
Trunk	−0.07	0.65	0.911	−0.66	1.08	0.541
Upper arm	0.37	0.37	0.320	0.07	0.63	0.914
Lower arm	−0.28	0.65	0.665	−1.47	1.06	0.166
Upper leg	−0.08	0.21	0.689	−0.23	0.35	0.519
Lower leg	0.02	0.27	0.955	0.84	0.44	0.060
Location on same limb as burn wound (yes)	−0.20	0.24	0.401	−0.27	0.41	0.513
Location adjacent to burn wound (yes)	−0.08	0.24	0.750	−0.01	0.41	0.987
Surface	0.01	0.00	0.789	−0.03	0.01	0.722
Time to re-epithelization (>2 weeks)	0.64	0.24	**0.008**	0.75	0.41	0.066
Wound infection	0.66	0.40	0.105	0.93	0.68	0.172
>1 time harvested	0.01	0.01	0.391	0.01	0.01	0.441
Use of pressure garment	−0.06	1.22	0.959	1.31	2.07	0.527
Use of silicone gel	0.74	0.38	0.054	1.04	0.67	0.118

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Table 3 – Multivariable mixed model analysis of predictors of long-term donor-site scar quality.

	Mean 6 item POSAS score[a]			Overall opinion score[b]		
Patient characteristics	R coefficient	SE	p-value	R coefficient	SE	p-value
Age (years)	−0.01	0.01	0.046	−0.02	0.01	0.045
Female gender	0.76	0.27	0.004	1.40	0.48	0.004
Fitzpatrick skin type	0.21	0.12	0.067			
Donor site characteristics						
Location				0.77	0.43	0.077
Lower leg						
Time to re-epithelization (>2 weeks)	0.66	0.26	0.017	0.79	0.39	0.044

[a] Explained variance: 32.3%.
[b] Explained variance: 17.3%.

were not correlated, which might indicate that the individual opinion of the patient is of more importance than biological or genetic factors. A younger age, female gender and time to re-epithelization were associated with reduced scar quality (both mean POSAS item score and overall opinion on the scar). In addition, a darker skin was associated with a poorer scar quality (POSAS item score) and location on the lower leg was associated with a poorer overall opinion of the patient.

A former study from our research group found that the agreement on donor-site scar quality between patients and caregivers is poor and that caregivers seem to underestimate the impact of donor-site scars in – a subgroup of- patients. Many studies have been performed on donor-site management, ranging from different types of wound dressings to more innovative (surgical) techniques. However, patient-reported outcomes were hardly reported [13]. Our results show that location on the lower leg was a predictor of reduced patient satisfaction, which might be due to the fact that this area is more often visible than the upper leg. Harvesting of the skin from a different location (i.e, buttocks or skull) may lead to a less visible donor-site and might therefore be a relatively simple option to improve overall satisfaction of patients. The use of other harvesting methods, like dermal and minced skin grafting, have been described to reduce donor-site morbidity [13–16]. Also, methods that aim to improve selective debridement (e.g. enzymatic or hydro-surgical debridement) of burn tissue may reduce the need for skin grafting and consequently, donor-site scarring [17,18]. If poor patient satisfaction regarding scar quality of a donor-site is expected, this might be an argument to support the decision to refrain from skin grafting. Local, pedicle and free flaps or the use of a skin stretching device for primary closure have been described as successful in the treatment of acute burn wounds and eliminate the need for donor-sites [19–21]. Another option, although costly and time consuming, is the use of allogenic skin substitutes or dermal regeneration products to support the wound environment and autologous regeneration in such way that skin grafting (and therefore donor-site scarring) may be reduced [17,18,22]. Conversely, if no problems regarding donors-site scar quality are expected, early debridement and skin grafting may lead to a decrease of the length of hospital stay [23].

Articles that report donor-site scar quality are scarce. Most investigate difference in cosmetic outcome after the use of different types of wound dressings and only a few used patient-reported outcome measurement instruments [13]. Schulz et al. evaluated donor-site scar quality ≥2 years after application of Biobrane or Dressilk in 11 patients and found that patients reported all POSAS items ≤2 for their donor-site scar. These lower POSAS scores might indicate that donor-site scar quality improves after one year. On the other hand, the patients that they included in their study were older, no children were included and more males were included compared to our study population. Similar to our results, color was appreciated worst [24].

To our knowledge, only two studies investigated the relationship between patient- and other clinical factors and patient-reported scar quality of donor-sites [25,26]. Karlsson et al. reported POSAS results 8 years after surgery that were similar to our study results, but did not find a significant relationship between age, sex, healing time and patient-reported scar quality. However, they invited patients retrospectively, resulting in a study population of only 27 patients. McBride et al. studied patient reported donor-site scarring in children, but did not find a relationship with age or sex [26]. Studies that assessed predictors of patient-reported quality of scars after general surgical procedures and burn injuries have, in line with our study, reported female gender as a predictor for a worse scar outcome [12,27,28]. Wallace et al. hypothesized that immune and hormone responses might result in hypertrophic scarring in females [29]. Nevertheless, other studies on hypertrophic scars did not find female gender as an independent predictor [30–32]. Garcia et al. state that their clinical observations showed that female burn patients frequently have greater difficulty choosing a donor-site location and therefore conclude that scar outcome in females is more important than in men [5]. This finding is comparable with a previous study that described that women express greater concern with their appearance than men [33]. Moreover, many studies on health related quality of life after burn injury report female gender as a predictor of a reduced health related quality of life [23]. This supports the gender differences in the patients' opinion found in our study and suggest that this outcome might be based on culture rather than biological differences between males and females. One study that used the patient scale of the POSAS to assess the quality of burn scars also found

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differences in age categories on the items pain, color, pliability and thickness [28]. It is important to realize that in children under the age of 5, parents complete the patient part of the POSAS. In literature, it has been stated that this may lead to underestimation of the true magnitude of the problem because pain and pruritus are difficult to assess through the parents [30]. On the other hand, parents may be very concerned about the appearance of the angular donor-site scars and how they evolve if their child grows and what they might think when they go into puberty.

An important strength of this study is that the study was conducted in a dedicated burn centre, and thus reflects donor-site outcome after specialized (scar) treatment. Another asset of the study was the prospective design which is preferred for the development of association and prediction models [34]. Because of the strict study protocol and study conduct there were no missing values in the patient-, clinical and donor site characteristics. Although patients signed informed consent, they were not aware of the predictors that we aimed to investigate and could therefore not influence the outcome. This study also has some limitations. We used the POSAS to assess scar quality and used arbitrary cut-off points in the absence of a commonly used cut-off point or a minimal important change analysis of the POSAS. Nevertheless, the POSAS is the only validated scar outcome measure that takes the opinion of the patient into account.

5. Conclusion

This study provides important new insights in long-term scar quality of donor-sites as stated by burn patients. Even one year after surgery the mean overall opinion of patients on donor-site scars was remarkably high (POSAS score 3.2 (scale 1–10)). Moreover, 37% of the patients reported a poor overall opinion on the donor-site scar (i.e. POSAS score $\geq$ 4). Especially color of the donor site-scars was judged to remain deviant from normal skin. A younger age, female gender, a darker skin type, location on the lower leg and prolonged time to re-epithelization predict patient-reported reduced donor-site scar quality. Our study provides data that can help to better inform patients on the long-term outcome of their injury. Furthermore, preventive and therapeutic measures can be tailored to further improve long-term donor-site scar quality.

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Conflict of interest

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