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Original Article

Split thickness skin graft versus application of the temporary skin substitute suprathel in the treatment of deep dermal hand burns: a retrospective cohort study of scar elasticity and perfusion

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Abstract: Two therapeutic options for deep dermal hand burns are autologous split-thickness skin graft (STSG) following tangential excision and the application of the temporary wound dressing Suprathel following removal of burn blisters. We compared elasticity and perfusion of burn scars after both types of therapy at least one year after completion of treatment. A case series of 80 patients of our department with deep dermal hand burns between 2013 and 2018 was examined in the year 2019 at least one year after completion of treatment (24 females and 56 males with a median age of 47.6 years). The clinical assessment of the scar was performed with the Vancouver Scar Scale (VSS) and Patient and Observer Scar Assessment Scale (POSAS) and the objective assessment with suction cutometry (MPA 580) and an O2C device on both hands. Our statistical analysis showed no statistically significant differences for the R2 and R5 elasticity values between the two types of therapy. The 95% confidence intervals for the ratios of elasticity, and microcirculatory perfusion parameters and scar scale scores of burn scars to respective healthy areas of skin after STSG and Suprathel-therapy mostly covered 1. Subgroup analysis of R2 viscoelasticity and analyses with adjustments for scar compression therapy, nicotine consumption, age, palmar or dorsal localization of the burn scar and interactions of age with smoking and localization gave similar results. The adjusted analysis of SO2 showed statistically significant lower SO2 values, 9% less, after STSG compared to Suprathel treatment. Split-thickness skin graft following tangential excision and the application of Suprathel following removal of burn blisters may be equivalent options for treatment of deep dermal hand burns. To detect possible small differences, further studies with larger samples are required.

Keywords: Hand burn, skin elasticity, split skin graft, scar, microcirculation, scar scale

Introduction

Burns are the fourth most frequent cause of injury worldwide [22] with 80-90% of severely burned patients suffering from hand burns [21, 25]. A retrospective study including 333 patients showed that 30% of hand burns needed operative treatment [35]. The most common complication of this injury is scar contracture relevantly reducing the hand function [35] and therefore the quality of life of these patients [5, 21]. To our knowledge, no publications comparing the abovementioned therapeutical options for deep dermal hand burns exist.

The synthetic skin substitute Suprathel is a 70-150 µm microporous hydrolytic absorbable membrane made of polylactic acid copolymer, which can lead to wound healing of partial-thickness burns injuries [13, 24]. Two common therapeutic options for deep dermal hand burns are autologous split-thickness skin grafts (STSG) following tangential excision and the application of the temporary skin substitute Suprathel following removal of burn blisters.

The aim of this retrospective clinical study is to compare the therapeutic outcome after these

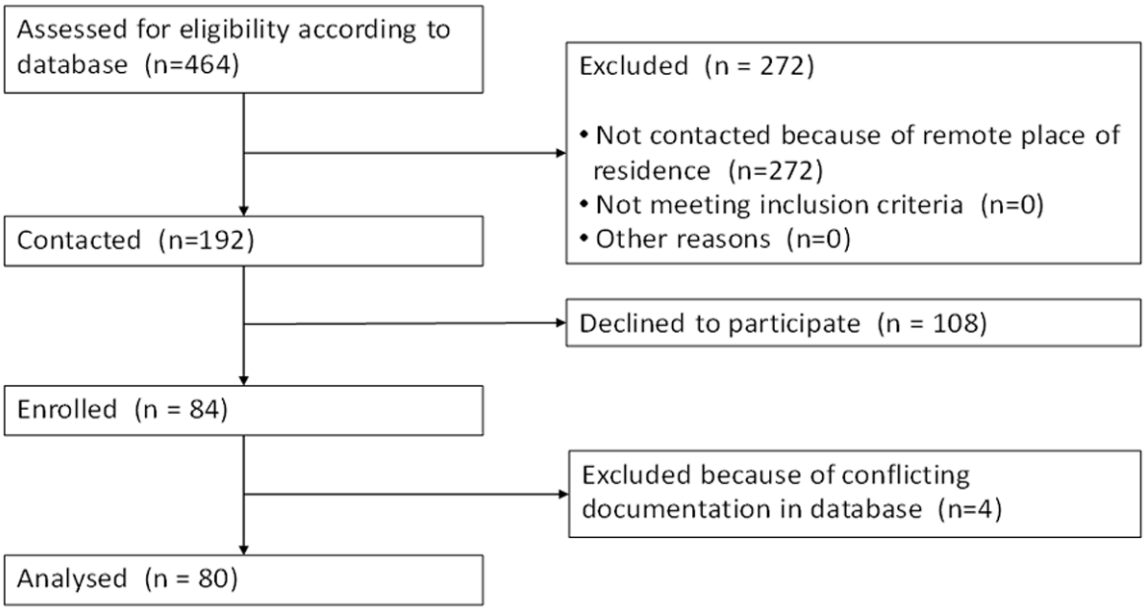

Figure 1. Flow diagram.

two types of therapy in terms of elasticity and perfusion of burn scars.

Material and methods

Patients of our department with deep dermal hand burns between 2013 and 2018 were recruited between March 2019 and December 2019 (**Figure 1**). The study was approved by the ethics committee of University of Luebeck (Germany) with the Reference Number 17-359 and all participants gave written informed consent. The eligibility criteria were patients with deep dermal burns, older than 18 years, ability to consent, at least one year since completion of one of both or both treatments. The exclusion criteria were hand infection and immunosuppression, as well as use of topical steroids.

The participants were required to undertake a single 30-40 minutes clinical examination which included: (a) the medical history of the patient, (b) a subjective burn scar assessment using Vancouver and POSAS scales, (c) objective measurements of skin elasticity of the scar and the respective healthy area of skin using Cutometer Skin Elasticity Meter MPA 580 (Courage-Khazaka Electronic GmbH, Cologne, Germany) and (d) objective measurements of local oxygen supply in the scar and the respective healthy area of skin using an O2C device (LEA Medizintechnik GmbH, Gießen, Germany).

Subjective assessment of the scars

The clinical assessment of burn scars was performed with the Vancouver Scar Scale (VSS) and the Patient and Observer Scar Assessment Scale (POSAS), which are both well-known and frequently applied scar scales [20].

VSS rates the burn scar on the basis of physical parameters like pigmentation, vascularity, pliability and scar height (Supplementary Material 1). It was introduced in 1990 and was used initially for the assessment of burn scars [31].

Patient und Observer Scar Assessment Scale (POSAS) comprises two different scales: the Patient Scar Assessment Scale (PSAS) und the Observer Scar Assessment Scale (OSAS) [6]. POSAS was introduced in 2004 to evaluate scars after breast cancer surgery [32]. OSAS is based on an assessment by the examiner of physical parameters of the scar, such as vascularity, thickness, pigmentation, pliability, surface area, relief. PSAS is based on patient's opinion regarding pain, pruritus, color and stiffness of the scar. The sum of OSAS and PSAS results in the total score of POSAS (Supplementary Materials 2, 3). High scores indicate pathological scarring.

Objective assessment of the scars

Measurements of skin elasticity of the scar and the respective healthy area of skin of the unaf-

Table 1. Meaning of microcirculatory parameters

Microcirculatory parameter	Meaning
Oxygen saturation of hemoglobin SO2 (%)	Represents the capillary-venous oxygen saturation and indicates the balance between oxygen delivery and consumption
Relative hemoglobin amount rHB (arbitrary units)	Shows the hemoglobin amount and the filling of microvessels in tissue. This parameter is an indicator for venous congestion.
Blood flow (arbitrary units)	Indicates ischemia or hyperemia in measured tissue
Blood flow velocity (arbitrary units)	This parameter is used only for the calculation of blood flow and not for the assessment of oxygen apply in tissue

fected hand were performed with Cutometer Skin Elasticity Meter MPA, a gold standard for elasticity measurements [2]. The device creates negative pressure which leads to a mechanical deformation of the skin [3]. This deformation is measured inside the probe with a non-contact optical system (a light source, a light receptor and two prisms) and is displayed as curves. The form of these curves is influenced by collagen and elastin content in skin. There are a lot of measurement parameters described in the literature, the most often used and very well documented are the R-Parameters. For our statistical analysis we used the R2 (visco-elasticity in % = Ua/Uf, resistance to the mechanical force versus ability of recovery) and R5 parameter (net elasticity in % = Ur/Ue, elastic part of the suction phase versus immediate recovery during relaxation phase) [3]. The closer these values are to 1, the higher the elasticity. We measured using mode 1 (constant Vacuum pressure 450 mbar, suction phase 2 seconds, relaxation phase 2 seconds, duration of measurement 12 seconds) and a 6 mm probe.

We evaluated the local oxygen supply in a burn scar and the respective healthy area of skin using an O2C. The O2C device was approved in 2002 for non-invasive measurements of microcirculatory parameters of blood perfused tissues (**Table 1**). The measurement method is reliable [11] and combines laser Doppler spectroscopy to determine blood flow and velocity and white light spectroscopy to determine oxygen saturation and hemoglobin amount [17]. We measured for one minute using a "LFx-29" probe at a measurement depth of 2 mm and the mean of these values was recorded.

Statistics

Primary and secondary endpoints: The primary endpoint is R2 viscoelasticity and secondary endpoints are R5 net elasticity, oxygen saturation of hemoglobin (SO2), relative Hemoglobin amount (rHB), blood flow and blood flow velocity, VSS score and POSAS score.

Sample size: For our statistical analysis, we used logarithms of ratios of measured values of the scar and the respective normal skin of the other hand. The R2 value of a hypertrophic scar differed from that of the healthy skin by a factor of 0.859 [10] or -14%. Only such definitely clinically relevant differences were of statistical significance. This value, displayed with the help of a logarithmic scale, is equivalent to -0.152. The dispersion was calculated from the logarithmized extremes of the abovementioned ratios by dividing the range by 2.7 or 2, depending on sample size [1]. We took the mean of standard deviations of logarithms of the resulting values, 0.338, which corresponds to coefficient of variation 35%. Such a difference of 0.45 standard deviations between two groups (with one of them being 50% bigger as the other) can be estimated in a 95% confidence interval, which does not cover 1, only by samples with 80 participants or more (nQuery Advisor 6.01).

Analyses

For assessment of the scare scales scores, we applied the U-test for difference in medians with exact 95% confidence intervals. In our exploratory data analysis, we adjusted for the effect of predictive factors. After we confirmed the normal distribution of data through a Q-Q plot, we applied the logit transformation in this case for our calculations. All continuous variables were described with the aid of arithmetic mean, standard deviation, median, quartile, minimum and maximum. The quartiles of the logarithmized variables were retransformed, the geometric mean was calculated from the

Table 2. Descriptive statistics: 101 measurements of burn scars of 80 patients after STSG and Suprathel application. Continuous data is presented by use of mean (standard deviation) and categorical variables with absolute (relative) frequencies

Characteristic	Total	STSG	Suprathel
Age in years [Mean, (SD)]	47.6 (16.3)	47.1 (17.6)	48.1 (15.1)
Sex			
Male (%)	73 (72.3%)	37 (50.7%)	36 (49.3%)
Female (%)	28 (27.7%)	14 (50%)	14 (50%)
Fitzpatrick skin type			
2 (%)	54 (53.5%)	28 (51.9%)	26 (48.1%)
3 (%)	45 (44.6%)	22 (48.9%)	23 (51.1%)
4 (%)	2 (1.98%)	1 (50%)	1 (50%)
Smokers (%)	26 (25.7%)	14 (53.8%)	12 (46.2%)
Localization			
Dorsal surface of the hand (%)	75 (74.3%)	41 (54.7%)	34 (45.3%)
Palmar surface of the hand (%)	26 (25.7%)	10 (38.5%)	16 (61.5%)
Scar compression therapy (%)	68 (67.3%)	39 (57.4%)	29 (42.6%)

Table 3. Prevalence of various comorbidities and complications among the 80 participants

Comorbidities and complications	Number	STSG	Suprathel
Diabetes	3	2	1
Lupus erythematosus	1	0	1
Multiple sclerosis[1]	2	2	1
Rheumatoid arthritis	1	1	0
Raynaud's disease	1	1	0
HIV seropositive	1	0	1
Coronary heart disease[1]	2	2	2
Wound healing disorder	1	0	1

[1]Patients who received both types of therapy were included in both cohorts.

arithmetic mean and the coefficient of variation from the standard deviation according to the following formula for the log-normal distribution: CV = (exp(SD^2-1))^0.5.

Estimands are the ratios of geometric means of the ratios of R2 viscoelasticity (R2 scar/R2 normal skin) for both types of therapy. Our null hypothesis is that this ratio is 1. A linear model with the fixed factor "type of therapy" and random factor "patient" was applied. The estimand is retransformed to percentage difference of group means.

Subgroups and adjustments

We divided the participants into subgroups defined by sex, nicotine consumption, scar compression therapy and localization of the scar. The subgroups were described with point estimators and the resulting differences with the use of confidence interval. *P*-values of interaction tests were calculated.

We performed analyses with adjustments for scar compression therapy, nicotine consumption, age, palmar or dorsal localization of burn scar, and interactions of age with smoking and localization using ACOVA without random effects.

Results

50 measurements of burn scars after Suprathel-treatment and 51 measurements after split-skin graft were performed. Patients who received both types of therapy were included in both cohorts. Frequencies of predictors are listed in **Table 2**, comorbidities and complications in **Table 3**.

Primary endpoint (R2 viscoelasticity)

We analyzed the primary endpoint in relation to type of therapy, nicotine consumption, scar compression therapy and sex (**Table 4**).

The 95% confidence intervals for the ratios of R2 values (log-normal distribution) of burn scars to respective healthy areas of skin after STSG and Suprathel therapy mostly covered 1. Consequently the R2 values after both therapies do not differ significantly (**Table 5**).

Secondary endpoints

We analyzed the secondary endpoints in relation to type of therapy (**Figures 2**, **3**).

The 95% confidence intervals for the ratios of secondary endpoints of burn scars to respective healthy areas of skin after STSG and Suprathel therapy cover 1 and seem to be wide for velocity and flow (**Table 5**). Subjective scales indicate equivalent outcome (**Table 6**).

Table 4. Geometric mean, coefficient of variation and ratio (95% confidence interval) of R2 values (log-normal distribution) in relation to type of therapy, nicotine consumption, scar compression therapy and sex

R2 ratio	Category Number	Geom. mean (CV)	Category Number	Geom. mean (CV)	Difference	95% CI
Type of therapy	STSG 51	1 (13.9%)	Suprathel 50	0.99 (15.8%)	1.13%	[-4.62%; 7.22%]. P = 0.71
Nicotine consumption	Yes 26	1 (15.4%)	No 75	0.99 (14.7%)	0.74%	[-6.03%; 7.99%]. P = 0.83
Compression therapy	Yes 68	1 (15%)	No 33	0.98 (14.6%)	1.64%	[-4.47%; 8.16%]. P = 0.67
Sex	Male 73	1 (15%)	Female 28	0.99 (14.5%)	0.34%	[-5.99%; 7.08%]. P = 0.92

Table 5. Geometric mean, coefficient of variation and difference (95% confidence interval) of micro-circulatory perfusion parameter values (log-normal distribution) in relation to type of therapy

Ratio	STSG N = 51		Suprathel N = 50		Difference	95%CI
	Geom. mean	CV	Geom. mean	CV		
R5	1.02	28.9%	1.05	50.8%	-3.43%	[-17.4%; 12.9%]. P = 0.66
SO2	0.94	21.3%	1.01	17.6%	-7.2%	[-14%; 0.15%]. P = 0.055
rHb	1.03	13.4%	1.01	10.3%	1.84%	[-2.84%; 6.74%]. P = 0.44
Velocity	1.07	34.8%	0.98	41.4%	9.29%	[-5.56%; 26.5%]. P = 0.23
Flow	1.04	95.8%	0.87	83.6%	19%	[-12.1%; 61.2%]. P = 0.26

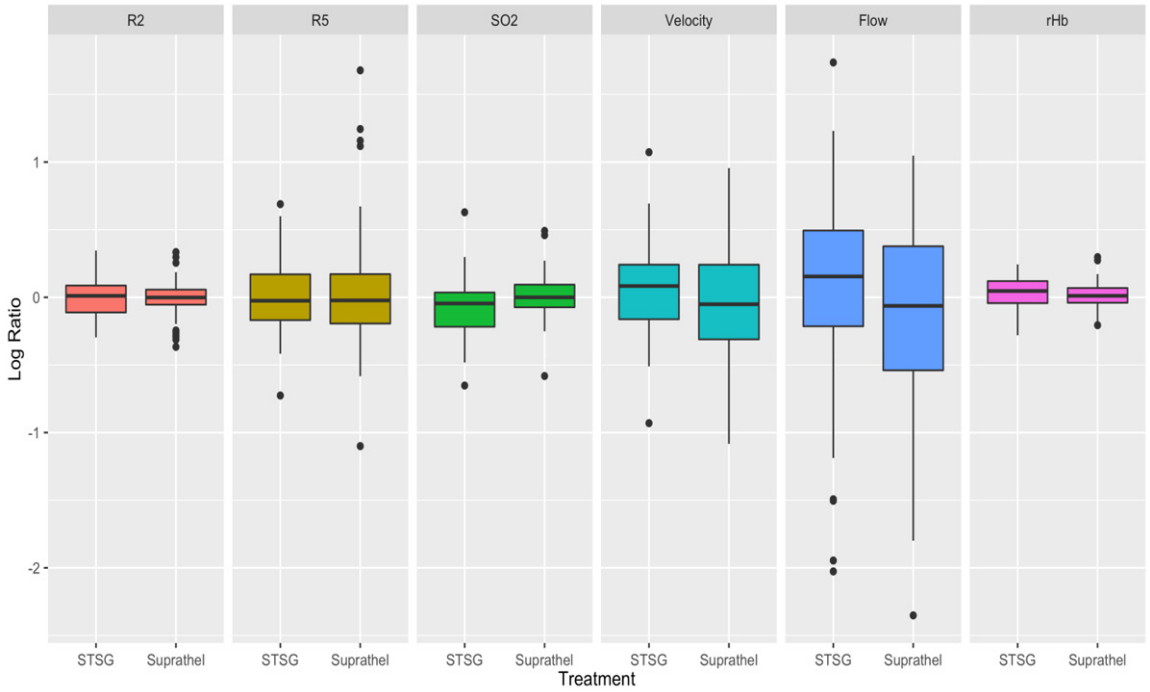

Figure 2. Display of log-transformed ratios of variables of skin elasticity and microcirculatory parameters in relation to type of therapy als box plots.

Subgroups and adjustments

The subgroup analysis of R2 viscoelasticity showed interactions between grouping variables, and the two types of therapy could not be inferred with any certainty.

Analyses with adjustments for scar compression therapy, nicotine consumption, age, palmar or dorsal localization of burn scar, and interactions of age with smoking and localization gave results (**Table 7**) similar to the unadjusted analyses.

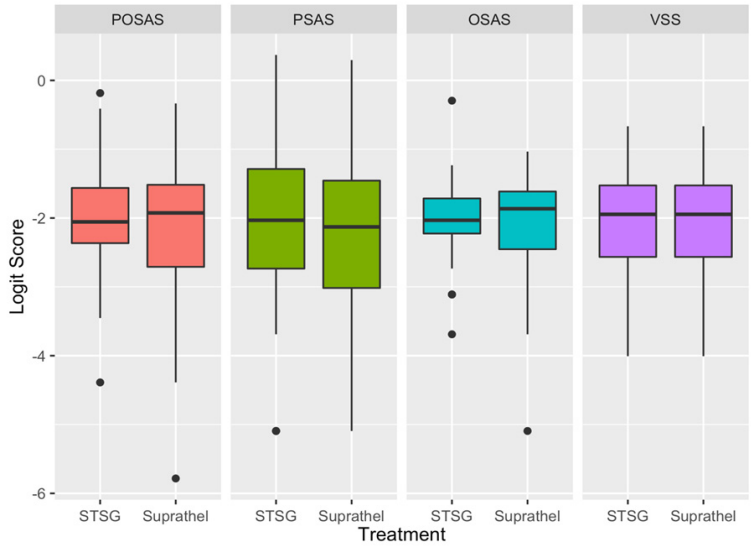

Figure 3. Display of logit-transformed scar scale scores in relation to type of therapy as box plots.

The adjusted analysis of SO2 showed statistically significant lower SO2 values, 9% less, after STSG compared to Suprathel treatment. Other geometric means differed more without statistical significance (**Table 7**).

Discussion

Skin elasticity

All layers of skin, including subcutis, influence to a varying extent its viscoelasticity [7]. As a result, the loss of epidermis and part of dermis after deep dermal hand burns leads to a decrease of skin elasticity and scar formation. In case of tangential excision, part of healthy dermis is in many cases intraoperatively removed [12] and replaced by the dermis of a split-skin graft. During the course of healing, the skin grafts develop secondary contracture and loose part of their elasticity [26].

The elasticity values after Suprathel application depend on duration of wound healing and possible formation of scar hypertrophy. Increased healing time and impaired healing is associated with worse scar quality [4, 8, 34]. Especially burns, which require more than 10-14 days to heal, are linked with higher risk for pathological scarring [4]. A prospective, open, controlled, non-inferiority study from 2009 including 18 patients with deep dermal burns on various body sites (except for hand) treated with STSG and Suprathel showed a prolonged time to healing after Suprathel application compared with STSG after tangential excision.

Another prospective noninferiority trial including the same 18 patients, published in 2013, evaluated VSS scores, POSAS scores und skin elasticity values of burn scars one year after STSG or Suprathel application [29]. Noninferiority was confirmed only for POSAS scores (except vascularity). VSS scores and cutometry showed comparable results without fulfilling the criteria of noninferiority.

Among our sample, there was only one 62-year-old otherwise healthy male patient with prolonged healing time after Suprathel application on the dorsal middle phalanx of the index finger. In this case no infection was reported.

The skin of the dorsal hand surface is thinner and prone to hypertrophic scarring contrary to the skin of the palm [27, 30]. Deep dermal hand burns in the region of joints and webspaces can lead to contractures and functional impairment [30]. An early operative treatment of such burns (72 hours after injury) and scar compression therapy can prevent the formation of hypertrophic scarring [9, 30] and should always be taken into consideration. A later operative correction of the burn scar after nonoperative treatment may not improve the hand function, due to possible contraction of its anatomic structures [30].

Our statistical analysis showed no statistically significant differences for the R2 and R5 values between the two types of therapy. Confidence intervals rule out differences that are more than half the difference between a stiff hypertrophic scar and healthy skin.

However, based on our experience, in individual cases treated with Suprathel, the skin appeared to be unstable and prone to fissures in the early period after completion of healing.

Microcirculatory perfusion parameters and scar scales scores

Reported risk factors for the formation of hypertrophic scars are dark skin, infancy and

Table 6. Median, quartile, difference of median and corresponding 95% confidence interval of scar scale scores in relation to type of therapy

Ratio	STSG N = 51		Suprathel N = 50		Difference	95%-CI
	Median	IQR	Median	IQR		
POSAS	24	21; 30.5	25.5	18.5; 31.2	-1.5	[-3; 4]. P = 0.9
PSAS	12	9; 17.5	11.5	8.25; 16	0.5	[-2; 2]. P = 0.79
OSAS	12	11; 14	13	10; 14.8	-1	[-1; 2]. P = 0.73
VSS	2	1; 3	2	1; 3	0	[0; 1]. P = 0.31

Table 7. Effect of treatment on the ratios of the examined parameters in an ACOVA without random effects with adjustments for scar compression therapy, nicotine consumption, age, palmar or dorsal localization of burn scar, and interactions of age with smoking and localization

Parameter	Ratio geom. Mean	95% CI	*P* value
R2	0.99	[0.93; 1.05]	0.66
R5	1.02	[0.87; 1.19]	0.84
SO2	1.09	[1.01; 1.18]	0.03
RHb	0.98	[0.94; 1.03]	0.39
Velocity	0.95	[0.82; 1.11]	0.52
Flow	0.85	[0.61; 1.16]	0.23
Odds POSAS	0.84	[0.58; 1.22]	0.36
Odds PSAS	0.88	[0.52; 1.5]	0.64
Odds OSAS	0.85	[0.63; 1.13]	0.26
Odds VSS	0.89	[0.63; 1.26]	0.5

Ratios >1 for measurements and <1 for assessments favour STSG.

adolescence, female sex, genetic predisposition, deep burn wounds especially on neck or arm, prolonged healing time, and transplantation of meshed skin graft [9, 16].

Hypertrophic burn scars after STSG show hyperemia and increased blood flow values compared to the normal ones [14, 18].

Publications report a significant correlation between POSAS, VSS and objective assessment of burn scars using suction cutometry [2]. Furthermore, POSAS and VSS correlate with healing time and therefore quality of burn scar [4, 8]. For that reason, these scar scales play an important role in clinical assessment of burn scars [2].

The adjusted analysis of SO2 showed statistically significant lower SO2 values after STSG compared to Suprathel treatment. Besides, no further significant differences regarding microcirculatory perfusion parameters and scar scales scores were found.

To our knowledge there are no studies in the literature defining the SO2 values of burn wounds and burn scars. This parameter represents the capillary-venous oxygen saturation and indicates the balance between oxygen delivery and consumption in tissue.

Just one of more than twenty comparisons was statistically significant at the local level 5%, as may be expected, when all null hypotheses hold true. This strengthens the conclusion of small differences.

Advantages and disadvantages of both types of therapy for deep dermal hand burns

Advantages and disadvantages of STSG: The main advantage of STSG is the shorter healing time comparing to Suprathel [15] and consequently lower risk for pathological scar formation [9] and better skin elasticity [10, 19].

Disadvantages are donor side morbidity, intraoperative blood loss, as well as other common surgery complications. Moreover, the patient outcome depends in this case on the expertise of the surgeon.

Advantages and disadvantages of Suprathel treatment: Advantages of Suprathel treatment are the absence of donor side morbidity and other common surgery complications, low wound infection rates and pain reduction during dressing changes [28, 33]. Therefore, Suprathel is a good alternative therapeutic option for deep dermal burns in elderly, chronically ill, multimorbid patients, as well as in severely burned patients with a lack of donor sites [15, 29].

The main disadvantage of this treatment is longer wound healing time compared to STSG and higher risk for hypertrophic scarring.

Limitations and strengths of the study

Limitations of this retrospective cohort study are the design and the relatively small sample size. The burn depth was clinically assessed by experienced burn surgeons of our department and was documented at the time of hospital admission as well as 48 hours later. The choice of treatment was always made by a consultant plastic surgeon according to associated burn injuries, extent of body surface burned and presence of comorbidities. Selection bias may have occurred as older, multimorbid or disappointed patients might be unable or unwilling to attend the medical examination.

The strength of this study is the statistical analysis which included control for a variety of potential confounding factors such as age, sex, scar compression therapy, nicotine consumption, palmar or dorsal localization of burn scar. The measurements were performed by the same person, a consultant plastic surgeon, under the same conditions and according to instruction manuals of the cutometer and O2C device.

Conclusion

Split-thickness skin graft following tangential excision and application of Suprathel following removal of burn blisters may represent equivalent options for treatment of deep dermal hand burns. To detect possible small differences, further studies with larger samples are required.

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Disclosure of conflict of interest

None.

Abbreviations

ANCOVA, Analysis of covariance; AU, Arbitrary units; CI, Confidence interval; CV, Coefficient of variation; Exp, Exponential function; Geom. Mean, Geometric mean; IQR, Interquartil range; log, natural logarithm; logit, logit transformation; M, Mean; OSAS, Observer Scar Assessment Scale; P, *P*-value (P = probability); POSAS, Patient and Observer Scar Assessment Scale; PSAS, Patient Scar Assessment Scale; Q-Q plot, quantile-quantile plot; rHB, Relative Hemoglobin amount; SD, Standard deviation; SO2, Oxygen Saturation of Hemoglobin SO2 (%); STSG, Split-thickness skin graft; VSS, Vancouver Scar Scale.

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Supplementary materials

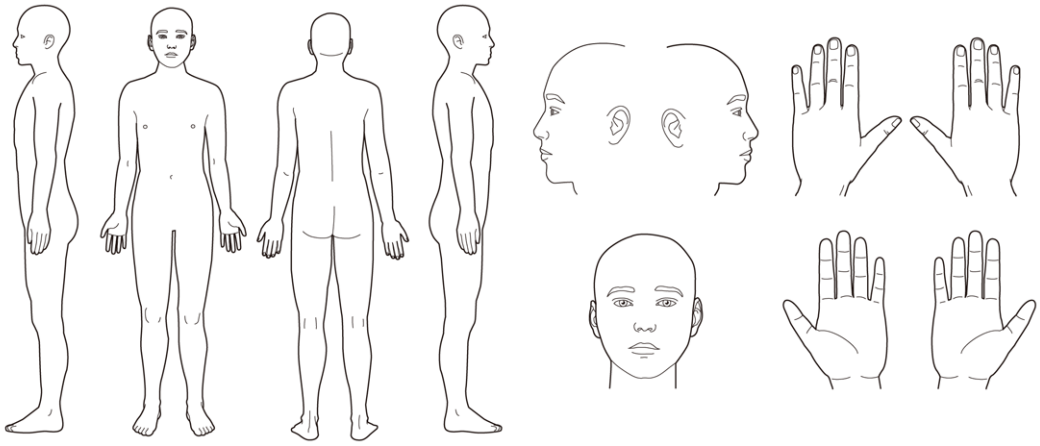
Scar characteristic	Score
Vascularity	
Normal	0
Pink	1
Red	2
Purple	3
Pigmentation	
Normal	0
Hypopigmentation	1
Hyperpigmentation	2
Pliability	
Normal	0
Supple	1
Yielding	2
Firm	3
Ropes	4
Contracture	5
Height (mm)	
Flat	0
<2	1
2~5	2
>5	3
Total score	13

Supplementary Material 1. Vancouver scar scale [31].

POSAS Observer scale

The Patient and Observer Scar Assessment Scale v2.0 / EN

Date of examination:	**Name of patient:**
Observer:	
Location:	**Date of birth:**
Research / study:	**Identification number:**



	1 = normal skin									worst scar imaginable = 10	
PARAMETER	1	2	3	4	5	6	7	8	9	10	**CATEGORY**
VASCULARITY	○	○	○	○	○	○	○	○	○	○	PALE | PINK | RED | PURPLE | MIX
PIGMENTATION	○	○	○	○	○	○	○	○	○	○	HYPO | HYPER | MIX
THICKNESS	○	○	○	○	○	○	○	○	○	○	THICKER | THINNER
RELIEF	○	○	○	○	○	○	○	○	○	○	MORE | LESS | MIX
PLIABILITY	○	○	○	○	○	○	○	○	○	○	SUPPLE | STIFF | MIX
SURFACE AREA	○	○	○	○	○	○	○	○	○	○	EXPANSION | CONTRACTION | MIX
OVERALL OPINION	○	○	○	○	○	○	○	○	○	○	

Explanation

The observer scale of the POSAS consists of six items (vascularity, pigmentation, thickness, relief, pliability and surface area).
All items are scored on a scale ranging from 1 ('like normal skin') to 10 ('worst scar imaginable').
The sum of the six items results in a total score of the POSAS observer scale. Categories boxes are added for each item. Furthermore, an overall opinion is scored on a scale ranging from 1 to 10.
All parameters should preferably be compared to normal skin on a comparable anatomic location.

Explanatory notes on the items:

- **VASCULARITY** Presence of vessels in scar tissue assessed by the amount of redness, tested by the amount of blood return after blanching with a piece of Plexiglas
- **PIGMENTATION** Brownish coloration of the scar by pigment (melanin); apply Plexiglas to the skin with moderate pressure to eliminate the effect of vascularity
- **THICKNESS** Average distance between the subcutical-dermal border and the epidermal surface of the scar
- **RELIEF** The extent to which surface irregularities are present (preferably compared with adjacent normal skin)
- **PLIABILITY** Suppleness of the scar tested by wrinkling the scar between the thumb and index finger
- **SURFACE AREA** Surface area of the scar in relation to the original wound area

Supplementary Material 2. POSAS observer scale [23].

POSAS Patient scale

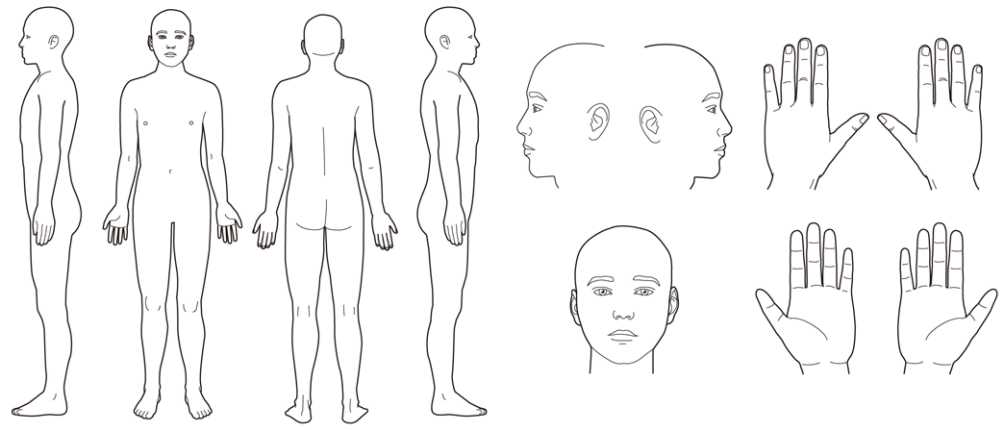
The Patient and Observer Scar Assessment Scale v2.0 / EN

Date of examination: | **Name of patient:**

Observer:

Location: | **Date of birth:**

Research / study: | **Identification number:**



1 = no, not at all — yes, very much = 10

	1	2	3	4	5	6	7	8	9	10
HAS THE SCAR BEEN PAINFUL THE PAST FEW WEEKS?	○	○	○	○	○	○	○	○	○	○
HAS THE SCAR BEEN ITCHING THE PAST FEW WEEKS?	○	○	○	○	○	○	○	○	○	○

1 = no, as normal skin — yes, very different = 10

	1	2	3	4	5	6	7	8	9	10
IS THE SCAR COLOR DIFFERENT FROM THE COLOR OF YOUR NORMAL SKIN AT PRESENT?	○	○	○	○	○	○	○	○	○	○
IS THE STIFFNESS OF THE SCAR DIFFERENT FROM YOUR NORMAL SKIN AT PRESENT?	○	○	○	○	○	○	○	○	○	○
IS THE THICKNESS OF THE SCAR DIFFERENT FROM YOUR NORMAL SKIN AT PRESENT?	○	○	○	○	○	○	○	○	○	○
IS THE SCAR MORE IRREGULAR THAN YOUR NORMAL SKIN AT PRESENT?	○	○	○	○	○	○	○	○	○	○

1 = as normal skin — very different = 10

	1	2	3	4	5	6	7	8	9	10
WHAT IS YOUR OVERALL OPINION OF THE SCAR COMPARED TO NORMAL SKIN?	○	○	○	○	○	○	○	○	○	○

Supplementary Material 3. POSAS patient scale [23].