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ORIGINAL ARTICLE

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Comparison of wound healing and patient comfort in partial-thickness burn wounds treated with SUPRATHEL and epicte^{hydro} wound dressings

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QRskin

Abstract

Among the available dressings for partial-thickness burn wound treatment, SUPRATHEL has shown good usability and effectiveness for wound healing and patient comfort and has been used in many burn centres in the last decade. Recently, bacterial nanocellulose (BNC) has become popular for the treatment of wounds, and many studies have demonstrated its efficacy. epicite^{hydro}, consisting of BNC and 95% water, is a promising product and has recently been introduced in numerous burn centres. To date, no studies including direct comparisons to existing products like SUPRATHEL have been conducted. Therefore, we aimed to compare epicite^{hydro} to SUPRATHEL in the treatment of partial-thickness burns. Twenty patients with partial-thickness burns affecting more than 0.5% of their total body surface area (TBSA) were enrolled in this prospective, unicentric, open, comparative, intra-individual clinical study. After debridement, the wounds were divided into two areas: one was treated with SUPRATHEL and the other with epicite^{hydro}. Wound healing, infection, bleeding, exudation, dressing changes, and pain were documented. The quality of the scar tissue was assessed subjectively using the Patient and Observer Scar Scale. Wound healing in patients with a mean TBSA of 9.2% took 15 to 16 days for both treatments without dressing changes. All wounds showed minimal exudation, and patients reported decreased pain with the only significant difference between the two dressings on day 1. No infection or bleeding occurred in any of the wounds. Regarding scar evaluation, SUPRATHEL and epicite^{hydro} did not differ significantly. Both wound dressings were easy to use, were highly flexible, created a safe healing environment, had similar effects on pain reduction, and showed good cosmetic and functional

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results without necessary dressing changes. Therefore, epicite[hydro] can be used as an alternative to SUPRATHEL for the treatment of partial-thickness burn wounds.

KEYWORDS

biological dressing, burns, reepithelialisation, wound healing

Key Messages

- epicite[hydro] can be used as a less expensive alternative to SUPRATHEL for the treatment of partial-thickness burn wounds
- we evaluated wound healing in 20 patients with partial-thickness burns to compare SUPRATHEL and epicite[hydro] wound dressings
- no significant differences were observed between the two dressings with regard to pain reduction, bleeding, infection, exudation, or scarring

1 | INTRODUCTION

Burn injuries are the fourth most common type of injury among all injuries worldwide.[1] While deep burn wounds require surgical treatment, various wound dressings have been developed for the treatment of superficial burns in the last decade.[2-4] The optimal wound dressing protects the wound against infection, has good biocompatibility, maintains a moist wound environment, and accelerates wound healing.[5-8] Furthermore, pain reduction during wound healing and decreased scar formation are important criteria for selecting an ideal wound dressing.[8-11] Nowadays, cost-effectiveness also plays a central role in the selection of suitable wound treatment products.[5,6]

Among the wide variety of available dressings, the synthetic dressing SUPRATHEL (PolyMedics Innovations GmbH, Denkendorf, Germany) has shown good usability and effectiveness in the treatment of partial-thickness burn injuries[6,11-14] and has been compared with a number of different wound dressings in the past. Schwarze et al compared SUPRATHEL with Omniderm (Omikron Scientific Ltd., Rehovot, Israel), a transparent, hydrophilic, polyurethane membrane, and found no significant difference in healing time but observed a significant reduction in pain scores and increased patient comfort in burn wounds treated with SUPRATHEL.[12] In another study, Hundeshagen et al compared SUPRATHEL with Mepilex Ag (Mölnlycke, Göteborg, Sweden), a silver-coated foam dressing, which was seven times cheaper and demonstrated significantly lower pain ratings in the SUPRATHEL group, as well as better elasticity 1 month after the burn injury.[6]

Owing to the high price of SUPRATHEL, the search for cost-effective alternatives with comparable properties continues.[6,12] One such alternative dressing is epicite[hydro] (QRSKIN GmbH, Würzburg, Germany), which consists of biotechnologically generated bacterial nanocellulose (BNC) synthesised by *Komagataeibacter xylinus* and 95% water.[15,16] The high amount of water incorporated in the cellulose reduces the intradermal temperature, wound progression, and pain through an evaporative cooling effect[17] and is loadable with antiseptic substances.[7,16,18-21]

The objective of this study was to directly compare epicite[hydro] with its significantly more expensive competitor SUPRATHEL for partial-thickness burn wounds in terms of patient comfort, wound healing, and scarring. epicite[hydro] and SUPRATHEL are both currently approved on the market as wound dressings and are therefore used within their intended range.

2 | METHODS

Prior to enrolling patients in the study, approval was obtained from the appropriate institutional review board (Project No.: 5/2017), and all patients provided written informed consent. The study protocol conformed to the ethical guidelines of the 1975 Declaration of Helsinki.

All patients aged 18 to 75 years who sustained partial-thickness flame, scald, or contact burns with more than 0.5% of their total body surface area (TBSA) affected were enrolled after consenting to participate in this prospective, unicentric, open, comparative, intra-individual clinical study.

Exclusion criteria were a lack of consent and compliance in the follow-up examinations, an existence of inhalation trauma, burns caused by chemical substances or electricity, localisation of the burned area in the face, an ABSI score of 10, pregnancy or nursing, patients with an active infection or a suicide attempt within the last 12 months, or mentally unstable patients as well as patients who were treated with topical agents or

pharmaceutical dressings prior to enrollment and admission. One patient who had an electrical burn was included in the study because the burn depth was only partial thickness and fasciotomy or escharotomy was not necessary.

A total of 20 patients meeting the eligibility criteria were enrolled between October 2018 and February 2020. Demographic data and data on medications administered by the treating emergency physicians were collected and documented.

On the day of admission, all wounds were cleaned mechanically with cotton gauze using Prontosan (B. Braun Melsungen AG, Melsungen, Germany) wound irrigation solution. The TBSA and burn depth were then estimated by a burn surgeon. If the attending physician assessed the depth as a partial-thickness burn and the patients agreed to take part in the study, the wound was divided into two areas: one was treated with SUPRATHEL and the other with epicite^{hydro}, simultaneously. After application, the wounds were covered with Jelonet (Smith & Nephew, Watford, England), Prontosan impregnated cotton gauze, and an external dressing.

The wound regime was analogous for both dressings in accordance with our standard of care. External dressing changes were performed regularly as long as exudation occurred. The two types of dressings both adhered to the wound over the course of wound healing and detached themselves independently after complete reepithelialisation.

The primary outcome measures investigated in this trial were infection, bleeding, exudation, and pain. Necessary dressing changes were also documented.

Exudation was analysed on days 1, 2, 4, 8, and 16 by visual inspection of an observer using the verbal rating scale (VRS) (0 = no exudate to 10 = maximal exudation). Pain was also analysed on days 1, 2, 4, 8, and 16 using a numerical rating scale (VRS) for pain (0 = no pain to 10 = the most extreme pain) as reported by the patient.

The secondary outcomes investigated in this study were time from wound treatment until wound healing (defined as <5% residual defect) and assessment of scar quality 3 and 6 months after injury. During these follow-up examinations, scar quality was assessed using the Patient and Observer Scar Scale (POSAS).[22-26]

TABLE 1 Patient aetiology

Pat. ID	Gender	Age (y)	TBSA	Burn cause	Study area
1	Male	46	11	Flame	Left and right knee
2	Female	36	7.5	Scald	Right arm
3	Male	41	12	Electricity	Right elbow/trunk
4	Male	46	9.5	Flame	Left and right forearm
5	Male	25	14	Explosion	Left and right forearm
6	Female	29	7	Scald	Left and right leg
7	Male	26	5	Flame	Left and right forearm
8	Female	44	5	Flame	Right hand
9	Male	61	23	Scald	Left shoulder and trunk
10	Male	18	10.5	Scald	Right forearm and leg
11	Male	55	19	Flame	Right arm
12	Male	20	13.25	Scald	Left leg
13	Female	23	13	Scald	Right arm
14	Male	27	12	Scald	Left leg
15	Male	33	1	Scald	Left and right hand
16	Female	36	2	Scald	Right forearm
17	Female	29	5	Flame	Left forearm and hand
18	Male	51	8	Scald	Right arm
19	Male	45	1	Explosion	Right hand
20	Female	40	5	Scald	Left and right leg
Mean		36.6	9.2		
SD		11.7	5.6		

Abbreviations: TBSA, total body surface area.

2.1 | Statistical methods

Comparisons of a priori hypotheses using t-tests and descriptive statistics were performed using Prism 9 software Version 9.0.0 (GraphPad Software, LLC., San Diego, California).

Statistical significance was accepted at $P \geq .05$.

3 | RESULTS

Among the 20 patients who completed the trial, the partial-thickness burns were mainly caused by scalds (55%), followed by flames (30%), and the injured body regions were mostly arms (55%), followed by legs (35%). The average TBSA was 9.2%, with a minimum of 1% and a maximum of 23%. The proportions of males and females were 65% and 35%, respectively, with a mean age of 36.6 years (Table 1).

3.1 | Wound healing

Both dressings were placed on the wounds and gradually cut back as reepithelialisation progressed until the dressings were completely detached. They were highly flexible, adapted to the skin surface easily during the initial application, and became stiff as they slowly dried out during the wound healing process. The primary dressings did not need to be changed during the study period, and no infections or bleeding after wound debridement were observed. A difference in application time was not observed. Dressing changes did not occur for both epicite^{hydro} and SUPRATHEL.

3.2 | Exudation

Wounds in general showed low exudation rates (mean of 2.7 VRS on day 1; $P = 1.0$) that decreased during the healing process (mean of 0.1 VRS on day 16; $P = 1.0$) without a significant difference between the two dressings (Figure 1).

3.3 | Pain

Patients rated their pain level using the VRS (0 = no pain at all to 10 = extreme pain). Wound-related pain scores were low (mean of 2.6 for epicite^{hydro} and 2.8 for SUPRATHEL on day 1; $P = .041$) and decreased during the healing process (Figure 2), solely with a significant difference between the two

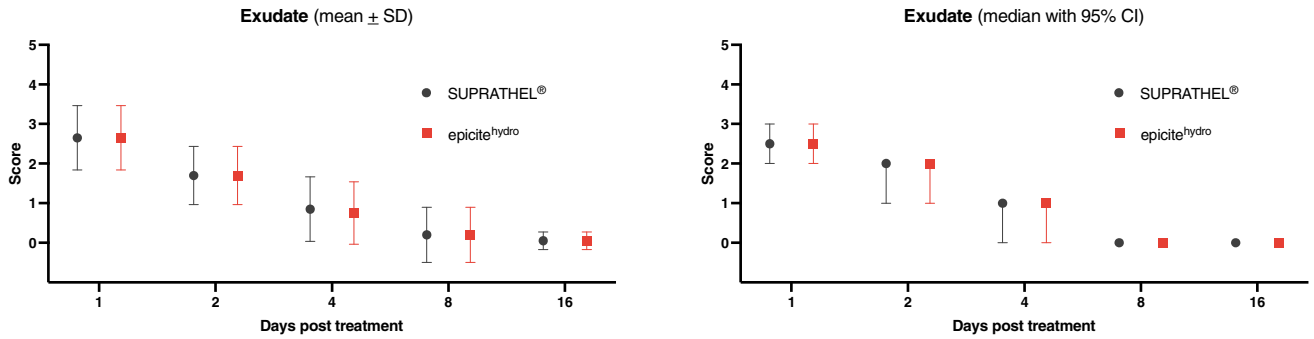

FIGURE 1 Exudation during wound healing (verbal rating scale 0-10). CI, confidence interval

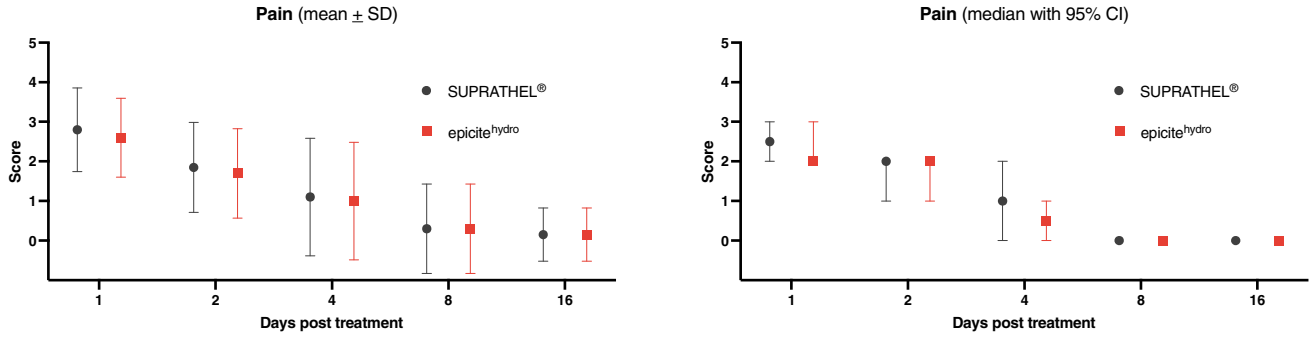

FIGURE 2 Pain during wound healing (verbal rating scale 0-10). CI, confidence interval

dressings on day 1 ($P = .083$ on day 2; $P = .163$ on day 4; $P = 1.0$ on day 8 and 16).

3.4 | Time for wound closure

Wound closure was documented for 18 of the 20 participating patients with a mean of 15.4 ± 4.9 days for wounds treated with SUPRATHEL and 16.1 ± 4.8 days ($P = .111$) for wounds treated with epicite^{hydro} (Figures 3 and 4).

3.5 | Scar evaluation

3.5.1 | POSAS by patient

Scores for pain, itching, stiffness, thickness, and irregularity after 3 and 6 months were generally low for both dressings. Overall scores including those for wound colour were in the midrange and decreased from 3 to 6 months post-injury. The distribution of scores showed a very similar pattern for both treatments, as shown in Table 2.

3.5.2 | POSAS by observer

Scoring performed by an observer was performed using a VRS (0 = normal skin to 10 = worst scar imaginable). Scores for thickness, relief, pliability, and surface area after 3 and 6 months were generally low. Overall, vascularity and pigmentation scores were in the midrange and decreased from 3 to 6 months (Table 2).

The majority of the collected data showed very low average values that did not show any significant difference or trend to a difference between treatments with the two dressings.

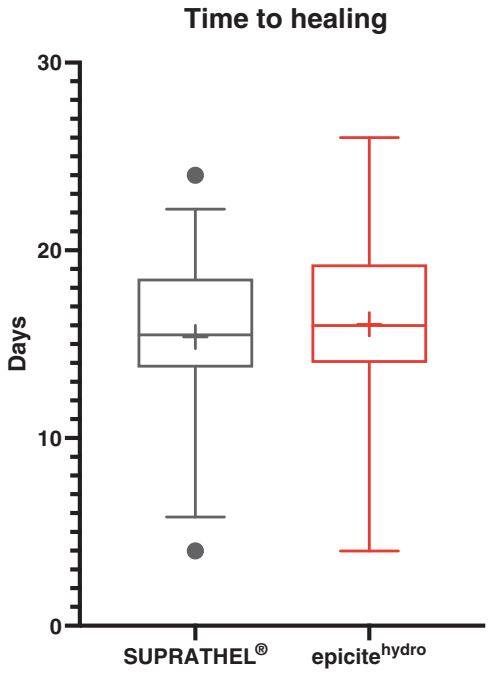

FIGURE 4 Graphical Analysis of data for the time up to conclusion of wound healing (Box and whiskers, 10%-90% percentile, + = mean)

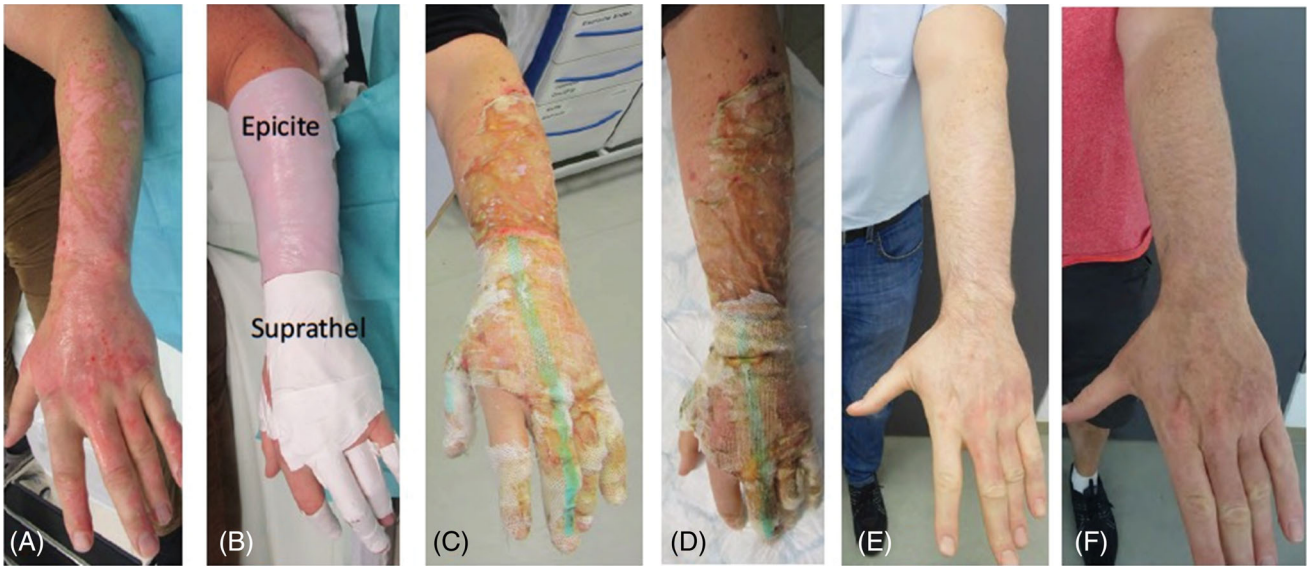

FIGURE 3 Partial-thickness burns of the arm and hand, A, after debridement, B, after application of the dressings, C, day 5, D, day 8, E, after 3 months, F, after 6 months

TABLE 2 POSAS Scores surveyed by patients or observers after 3 and 6 months

	SUPRATHEL			epicite^{hydro}			
	Mean	**SD**	**Median**	**Mean**	**SD**	**Median**	***P*-value**
POSAS patient							
Pain 3 mo	1.20	0.52	1	1.20	0.89	1	1.000
Pain 6 mo	1.45	1.60	1	1.55	1.32	1	.541
Itching 3 mo	2.20	1.82	1	2.05	1.82	1	.762
Itching 6 mo	2.40	2.80	1	2.30	2.48	1	.541
Colour 3 mo	5.35	2.62	5	5.30	2.90	5	.938
Colour 6 mo	4.20	2.57	4	4.05	1.93	4	.769
Stiffness 3 mo	1.60	1.50	1	1.65	1.72	1	.909
Stiffness 6 mo	2.05	2.26	1	1.35	0.93	1	.209
Thickness 3 mo	2.10	1.83	1	2.25	2.07	1	.774
Thickness 6 mo	1.65	1.39	1	1.60	1.05	1	.895
Irregularity 3 mo	2.75	2.47	1	2.65	2.48	1	.837
Irregularity 6 mo	2.00	1.59	1	1.65	1.18	1	.330
Overall 3 mo	4.50	2.44	5	4.50	2.80	4	1.000
Overall 6 mo	3.70	2.08	3	3.55	1.99	3	.643
POSAS by observer							
Pain 3 mo	4.05	1.50	4	3.55	1.64	3	.163
Pain 6 mo	2.50	1.54	2	2.25	1.41	2	.449
Itching 3 mo	3.55	1.10	4	3.45	1.94	3	.807
Itching 6 mo	2.70	1.63	3	2.75	1.41	3	.874
Colour 3 mo	1.55	1.67	1	1.25	0.72	1	.467
Colour 6 mo	1.45	1.15	1	1.20	0.52	1	.349
Stiffness 3 mo	1.60	1.70	1	1.10	0.31	1	.196
Stiffness 6 mo	1.40	1.00	1	1.35	0.67	1	.825
Thickness 3 mo	1.00	0.00	1	1.10	0.31	1	.163
Thickness 6 mo	1.40	1.27	1	1.15	0.67	1	.171
Irregularity 3 mo	1.30	0.92	1	1.05	0.22	1	.262
Irregularity 6 mo	1.25	0.91	1	1.20	0.62	1	.748
Overall 3 mo	3.70	1.63	4	3.10	1.45	3	.163
Overall 6 mo	2.95	1.40	3	2.70	0.89	3	.383

Abbreviation: POSAS, Patient and Observer Scar Scale.

4 | DISCUSSION

Scars, which are clearly visible to everyone, can be a burden for patients and may have negative effects on social life and self-confidence, and can even lead to depression.[27-29] Therefore, the cosmetic appearance of scars is often very important to patients. In the past few years, biosynthetic dressings have been produced to create an ideal replacement for human skin. Ideally, these dressings should: fit closely to the wound bed, be highly flexible, allow for exchange of water vapour, be long-lasting, create a barrier against bacteria and contamination, be transparent in order to recognise infections easily, be easy to handle with a simple application and removal process, accelerate wound healing, produce acceptable cosmetic results, and be low in cost.

epicite^{hydro} and SUPRATHEL both seem to provide these aspects. For an in-depth comparison, an intra-individual, prospective, clinical study was conducted.

In this study, both dressings offered a safe healing environment without infection and high levels of patient comfort for the treatment of partial-thickness burns, without the need for painful dressing changes.

Karlsson et al described their experiences in the use of biosynthetic cellulose dressings in burns and reported an infection rate of 39%.[7] They treated 18 patients with superficial burn injuries with a mean TBSA of 8.2%. The median healing time was 28 days (13-80 days), which is appreciably higher than the time for final closure in the epicite[hydro] treated wounds in the current study (16.1 days).[7] Karlsson et al also reported patients who described that the cellulose got "stiff" over their joints.[7] In the current study, no patient complaints about stiff wound dressings were documented, but most dressings were not applied over joints. In addition, Maurer et al compared polyurethane foam dressings with BNC sheets and reported that the length of hospitalised care and procedures requiring anaesthesia were significantly reduced in the nanocellulose group.[8]

Partial-thickness burn injuries are accompanied by pain. Therefore, pain reduction is one of the most important properties of wound dressings. In the literature, SUPRATHEL showed better pain reduction than Mepilex Ag[6] and Omiderm.[12] There are even studies that report an analgesic effect on burn wounds[6,30] and donor sites[31] for SUPRATHEL. In this study, the reported pain scores for SUPRATHEL- and epicite[hydro]-treated burn wounds were generally low and decreased during the healing process. Due to ethical reasons, no burn wound received none of the two dressings. Therefore, we do not know, if both dressings had an analgesic effect. Nevertheless, epicite[hydro] showed similar pain scores compared with SUPRATHEL, which is in accordance with results found in previous studies.[7,8,32]

Superficial partial-thickness burn wounds normally heal without scarring or with minimal scarring. With professional wound care and infection prevention techniques, wound healing is completed in 2 to 4 weeks.[33] epicite[hydro] and SUPRATHEL are modern biosynthetic wound dressings that accelerate wound healing and minimise scarring.[34-36] In this study, wound healing of partial-thickness burn wounds was completed after 15.4 and 16.1 days with SUPRATHEL and epicite[hydro], respectively, which was higher than the time of reepithelialisation reported in previous studies dealing with partial-thickness burn wounds of 12[6] and 13 days[12] for adults as well as 10.2 days,[11] 10 days,[37] and 12 days[8] for children, respectively. One explanation for this phenomenon is the higher mean of affected TBSA in this study compared with other studies (9.2% vs 5.5% and 4.0%, respectively)[6,11] as well as the inclusion of partial-thickness burn wounds with deeper areas, which also prolongs wound healing.

Some cases reported in the literature showed a higher degree of scarring or intermittent scarring in the treated areas, or a skin reaction, such as dermatitis, after application of wound dressings.[38] These findings were not confirmed in this trial, solely a slightly higher pigmentation rate in the burned areas treated with SUPRATHEL was observed.

In contrast, other groups described improved scar properties for SUPRATHEL-treated superficial burn wounds and donor sites.[14,39]

In a previous study, it was described that SUPRATHEL costs 0.56$ (United States Dollar) per square centimetre.[6] For our hospital epicite[hydro] is 3.6 times cheaper than SUPRATHEL, usually depending on the individual price negotiation between the hospital and the manufacturer. Therefore, epicite[hydro] is more cost-effective than SUPRATHEL.

4.1 | Limitations

This study had several limitations. First, the study group was rather small and comprised only 20 patients. Multicentre studies with larger sample sizes are needed to validate our results. Furthermore, burn depth was only assessed clinically.

5 | CONCLUSION

Both wound dressings used in this study were easily handled, did not need to be removed or exchanged, were highly flexible, created a barrier against bacteria, showed no infections, had similar effects in pain reduction, and showed good cosmetic and functional results. Additionally, comparable healing times were observed with epicite[hydro], which is more cost-effective than SUPRATHEL. Therefore, epicite[hydro] can be used as an alternative, cost-effective, wound dressing to SUPRATHEL for the treatment of partial-thickness burn injuries.

CONFLICT OF INTEREST

The authors disclose the following commercial associations that might create a conflict of interest in connection with the submitted manuscript: This research was supported by QRskin (Germany). Hereby QRskin had no influence in the planning and implementation of the study. Furthermore, QRskin had no influence in the data collection.

DATA AVAILABILITY STATEMENT

Data is available upon request.

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