The use of MatriDerm® and skin graft for reconstruction of complex wounds

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MatriDerm® (MedSkin Solution Dr. Suwelack) is an engineered dermal template developed to provide a one-step repair of full-thickness skin defects. It has been found to be effective in burn wounds, but not many reports are available for its usage to reconstruct other types of complex wounds. In this prospective study, the authors report on 2 years' experience using Matriderm for the coverage of complex wounds. To the best of the authors' knowledge, this is the first report from Kuwait focusing on the effectiveness of MatriDerm.

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There are several methods used for coverage of full-thickness skin defects. These range from simple skin grafts to more complex flap surgery, either local, distant or even free flaps (Gümbel et al, 2016). The use of full-thickness skin grafts is limited, due to the size and availability of suitable donor sites.

Split-thickness skin grafts (STSG) can be used for coverage of larger defects. STSG have several adverse issues, such as hypertrophic scarring, keloids or disabling contractures especially across joint surfaces (Choi et al, 2014). This has led to the development of dermal templates in order to improve the quality and functionality of the reconstructed skin (Choi et al, 2014).

Dermal substitutes are a heterogeneous group of biological and/or synthetic elements that enable the temporary or permanent coverage of wounds. They vary from skin xenografts or allografts to a combination of autologous keratinocytes over the dermal matrix (Shores et al, 2007). Acceptable aesthetic and functional results mimicking a full-thickness skin graft have been achieved using a one-stage dermal substitute and an STSG with negative pressure wound therapy (NPWT; Kim and Hong, 2007).

In recent years, many studies have shown good results using dermal substitutes in the coverage of acute and chronic wounds (van Zuijlen et al, 2000). These have been widely used in traumatic wounds, burn injuries, soft tissue reconstruction after tumour resection, coverage of donor areas after flap harvest and diabetic foot ulcers (Alagaratnam et al, 2012; Rehim et al, 2014).

MatriDerm® (MedSkin Solution Dr. Suwelack) is an acelluar dermal substitute composed of collagen and elastin that is used for reconstruction using STSG (Kang et al, 2019). The elastin is obtained from the bovine nuchal ligament by hydrolysis, while collagen is derived from the bovine dermis (Min et al, 2014). MatriDerm provides a scaffold to restore the skin, reduces haematoma formation and improves scar properties (Min et al, 2014).

In Kuwait, there are no reports assessing short or long-term outcomes for MatriDerm application for wound coverage. In this paper, the authors report their 2 years' experience with MatriDerm as a reconstructive tool for coverage of difficult and complex wounds.

Methods

Between February 2015 and January 2017, the authors conducted a prospective study of patients with complex wounds treated with MatriDerm and STSG at their plastic and reconstruction surgery unit at Adan Hospital, Kuwait.

For all patients, patient demographics, cause of wounds, size, site and wound bed characteristics, as well as type of extremity fixation in case of associated fractures, were documented. Operative details, such as type of anaesthesia and combined usage of NPWT, were also included. The authors recorded

Table 1. Patient demographics and wound details.

No.	Age	Sex	Location	Wound type	Size (cm)	Wound bed	Comorbidity	% take	Complication
1	27	F	Right leg	Traumatic	21 × 11	Granulation	None	100	None
2	17	F	Left thigh	Traumatic	45 × 19	Granulation	Morbidly obese	70	Infection (localised)
3	17	M	Right knee	Traumatic	9 × 6	Granulation	None	100	None
4	37	M	Right foot	Traumatic	7 × 5	Exposed tendon	None	50	None
5	45	F	Left leg	Traumatic	13 × 8	Exposed tendon	None	100	None
6	35	M	Right forearm	Traumatic	18 × 7	Exposed tendon	None	100	None
7	5	M	Left leg	Traumatic	7 × 4	Granulation	None	80	None
8	55	M	Right leg	Infection (necrotising fasciitis)	16 × 8	Exposed bone	Diabetes and hypertension	100	None
9	21	M	Sacrum	Pressure ulcer	13 × 13	Granulation	Quadriplegic, bedridden	0	Infection (*Pseudomonas*)
10	6	M	Right forearm	Traumatic	8 × 5	Muscle	None	100	None
11	29	F	Left foot	Infection (diabetic foot)	7 × 6	Exposed tendon	None	100	None
12	49	M	Left foot	Traumatic	9 × 6	Granulation	None	95	None
13	43	M	Left leg	Burn	36 × 8	Granulation	Smoking	100	None
14	12	M	Right foot	Traumatic	8 × 7	Granulation	None	50	None
15	23	F	Abdomen	Infection	24 × 39	Granulation	None	100	None
16	27	F	Left thigh	Traumatic	29 × 16	Granulation	None	90	None
17	8	M	Left forearm	Traumatic	14 × 7	Granulation	None	70	Contracture
18	38	M	Right leg	Traumatic	18 × 11	Exposed bone	None	100	None
19	55	F	Left leg	Vascular	4 × 3	Exposed vessel	Diabetes and hypertension	0	Non-healing
20	27	F	Right knee	Traumatic	7 × 6	Granulation	None	100	None

information from the follow-up period, including time of complete wound healing and engraftment rate, short-term complications (haemorrhage, infection and loss) and long-term complications (contracture, range of movement, scar acceptance, reulceration, skin colour and elasticity).

Patients filled in a questionnaire about their final satisfaction with their treatment.

A total of 20 patients were grafted with MatriDerm and STSG. *Table 1* shows the demographic details of these patients and their wounds. Twelve women (60%) and eight men (40%) between the ages of 5 and 55 years (mean age 28.8) were included. The majority (80%) of the patients were younger than 40, and only 25% of them had one or more comorbidities, such as diabetes, hypertension, smoking or morbid obesity.

MatriDerm was used to cover post-traumatic raw areas in 13 patients (65%). Other causes were acute burn, pressure sore, necrotising fasciitis and diabetic foot. Fifteen cases (75%) involved the lower extremity, with only nine cases (45%) with exposed tendon, bone or both. Five cases (25%) had associated fractures; three of these (15%) had internal fixation with plate and screws, while the others were managed with external fixators. Most of the cases (80%) underwent the procedures under general anaesthesia, and the remaining were done under regional or local anaesthesia.

All patients formally consented after acceptance of the procedure from the authors' institute ethical committee.

Surgical techniques

All wounds were previously prepared by

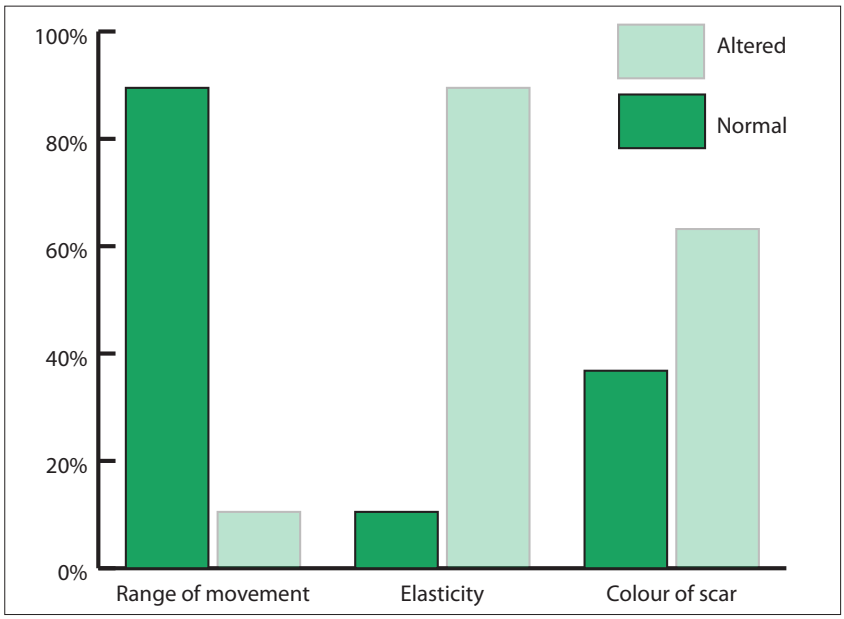

Figure 1. Subjective assessment of the scar quality with MatriDerm. Decreased range of movement (ROM) was seen in 10.5%, while 10.5% described normal skin elasticity and 36.8% had normal scar colour.

surgical debridement and NPWT. On application, any slough, exudate or unhealthy tissue were debrided. Perfect haemostasis was obtained and a MatriDerm layer of 1.0 mm thickness was carefully cut to size. The matrix was rehydrated in the wound bed by 0.9% physiological saline solution. Autologous STSG was applied and fixed with staplers and covered with sterile non-adherent gauze. NPWT (–125 mmHg) was applied in 17 cases (85%). In the other three cases, the classic tie over dressing was used. The first dressing changes were carried out on the fifth postoperative day, where classic dressing was applied (non-adherent dressing with gauze and crêpe bandage).

Results

The average engraftment rate of MatriDerm and STSG was 80.25 ± 32%. There were two cases of infection; one was localised (patient 2) and resulted in 30% loss of the graft, which healed conservatively. The other case was severe infection (patient 9) in a sacral pressure sore, which led to total loss of the graft. The second case of total loss was in a patient (no. 19) with severe peripheral vascular disease, who had a simultaneous bypass graft that failed after 4 days. The patient then had a below-the-knee amputation.

The mean follow-up period was 9.15 months (range 1–24 months), with the exception of one patient who travelled back to his country after 1 month. Mean time of complete wound healing was 23.7 days (range 10–60 days).

Subjective assessment of the scar quality with MatriDerm and STSG was carried out *[Figure 1]*. Decreased range of movement was seen in 10.5% of patients. Only 10.5% described normal skin elasticity, 52.6% had moderate elasticity and 26.9% had no elasticity. Scar colour was normal in 36.8% of patients, with 63.2% having hyperpigmentation in the MatriDerm and STSG area. The patient satisfaction scores showed 42% of patients were very satisfied, 36.8% were relatively satisfied and 21% of patients were unhappy with the outcome.

Twelve patients (63.2%) had no long-term complications. No serious long-term complications or mortality occurred. There was one case of reulceration (5.2%), and six patients (31.6%) complained of unacceptable scarring. *Figures 2* and *3* show two of the cases.

Discussion

Until the end of the last century, the gold standard treatment for covering full-thickness skin defects was the use of a full-thickness skin graft in small defects and STSGs in larger defects (Yannas and Burke, 1980). Dermal substitutes were developed to serve as a template for dermal repair and to improve the quality of scar tissue (Yannas and Burke, 1980).

One of the popular dermal substitutes is acellular dermal matrix. AlloDerm (LifeCell) is one of the most used acellular dermal matrix preparations. It is obtained from cadaveric skin and allows improvement in the structure of the dermis (Yim et al, 2010). However, there are some limitations to the use of human-derived skin products, especially in the Middle East, and specifically in Kuwait.

Other commonly used dermal substitute worldwide and specifically in the authors' centre is Integra® (Integra Life Sciences). The authors have reported its use in diabetic foot reconstruction recently (Ben Nakhi and Eltayeb, 2018). However, because of its relative high costs and the need for a two-stage procedure, there is a need for a less expensive dermal substitute material that can be used in one stage.

MatriDerm is an inexpensive, artificial dermis that can be used as in single stage reconstruction. Enoch and Kamolz (2012) summarised the indications for the use of MatriDerm in the treatment of complex wounds, such as full-thickness wounds, trauma, skin cancer excisions, acute and reconstructive phases of hand and joint injuries due to flame burns.

Several large case series have been reported describing the successful use of MatriDerm in

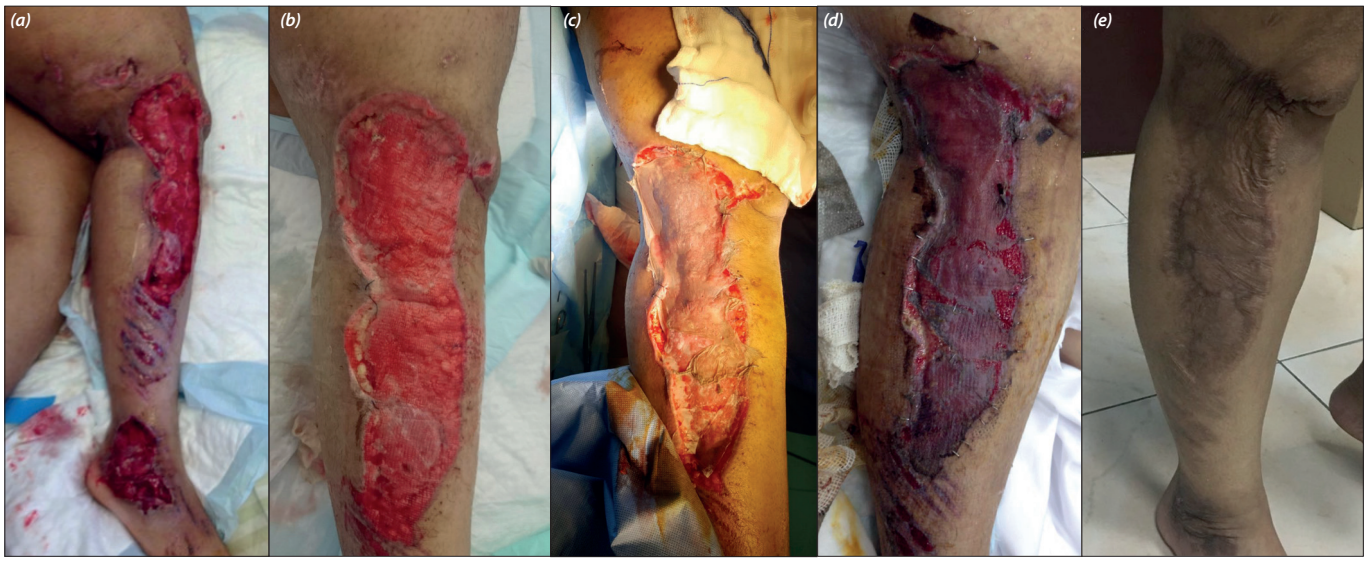

Figure 2. Patient no. 1 (a) Post-traumatic degloving injury of the right leg. (b) Status after NPWT. (c) Intra-operative view with MatriDerm seen exposed in the lower wound and covered with STSG on the upper part. (d) First dressing on the fifth post-operative day. (e) Follow-up at 24 months post-operation.

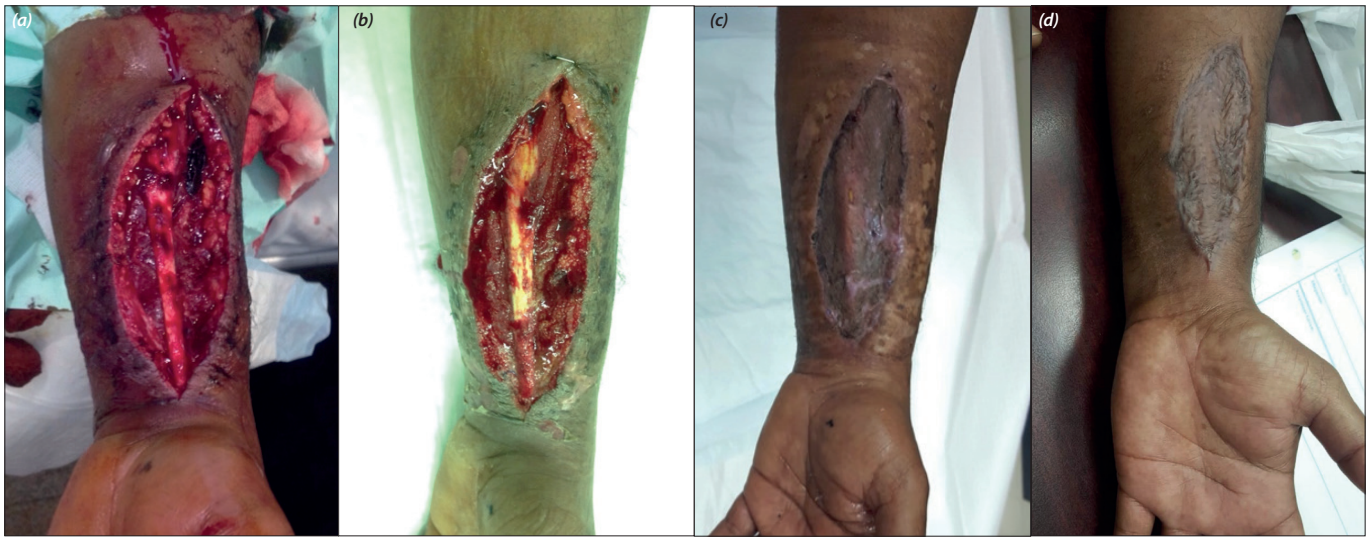

Figure 3. Patient no. 6 (a) Post-traumatic fasciotomy of the right forearm with exposed tendon. (b) Wound after debridement and NPWT. (c) Three weeks post coverage with 100% engraftment of Matriderm and STSG. (d) Three-month follow-up.

different wounds, including burns (Lee, 2015), melanoma defects (Campagnari et al, 2017), necrotising fasciitis (Ryssel et al, 2010) and diabetic foot ulceration (Jeon et al, 2013).

MatriDerm was used to cover traumatic wounds with exposed tendons, diabetic foot, necrotising fasciitis, burn, bedsores and revascularised ischaemic wounds.

Foam-based NPWT was applied in the majority of the cases (85%) to improve autologous STSG engraftment by reducing the rate of seroma or haematoma formation and reducing shear forces between the graft and wound bed. Reports have shown that NPWT induces angiogenesis and, therefore, improves blood flow via existing channels through biomechanical effects or induction of moderate hypoxia in the wound bed (Baldwin and Potter, 2009).

Goutos and Ghosh (2011) have studied the potential use of gauze-based NPWT (as opposed to foam-based NPWT) with MatriDerm resurfacing. They found that it helped bolstering the one-step MatriDerm templates onto wounds and contributed to excellent rates of epithelialisation (mean 94%; range 70–100%).

Regarding the survival of the autograft, Ryssel et al (2008) found no statistically significant reduction of graft take for areas treated with dermal substitution and synchronous skin grafting in burn cases.

The authors found a lower STSG take when combined with MatriDerm, with an engraftment

rate of only 80.25%. The authors strongly believe that increased diffusion distance for nutrients and oxygen to reach the autograft after interposition of the substitute may affect the survival of the graft. It was noticed that the graft needs more time to be fixed, compared to STSG without MatriDerm. This theory has been postulated before by Ryssel et al (2008). They overcame this problem by using thinner mesh skin grafts, which has apparently improved the survival of the autografts.

Bloemen et al (2010) reported their 12-year follow-up of dermal substitute used in 46 patients with acute burns, and found improved scar parameters in both acute and reconstructive substituted wounds, indicating a long-lasting effect on scar quality.

Although mean follow-up period was short, at 9.15 months (range 1–24 months), only 10% of the authors' patients experienced altered range of movement. Longer follow-up is necessary to observe if any further changes will occur over time, whether improvement or worsening.

Min et al (2014) had found that grafted skin in combination with MatriDerm has an elasticity like normal skin. The authors had noticed subjectively decreased elasticity in more than half of the cases. Only 10.5% of patients described normal skin elasticity, 52.6% had moderate elasticity and 26.9% had no elasticity. However, this difference was not studied objectively.

Subjective assessment in burn scars reconstruction has shown several statistically significant differences in favour of MatriDerm, such as pliability, relief, pigmentation and the quality of the healed wound (Enoch and Kamolz, 2012).

More than 50% of patients complained of hyperpigmentation. Most of the cases were in dark skin types (skin type 4 and 5). *Table 2* shows a comparison of the authors' current study with two retrospective studies (Choi et al, 2014; Gümbel et al, 2016).

Table 2. A comparison of the current study with two retrospective international studies.

	Choi et al (2014)	Gümbel et al (2016)	Current study
Study type	Retrospective	Retrospective	Prospective
Number	34	56	20
Mean age (years)	48	49.1	28.8
Follow-up (months)	6	NA	1–24 (9.15)
Engraftment (%)	96	73.2	80.25
Long-term complications	0	1 case (failure)	1 case (ulceration)

Conclusion

To the best of the authors' knowledge, this is the first paper describing the experience of MatriDerm in Kuwait. The current non-randomised prospective study supports the premise that MatriDerm and skin graft provides effective single-stage coverage of certain complex wounds. However, the authors strongly believe there is a need for randomised controlled trials examining the effectiveness of MatriDerm before recommending its widespread use in clinical practice. WME

Conflict of interest

None.

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