Review

Epidermal grafting

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Abstract

Skin grafting is an intervention used for the closure of many types of wounds and involves removing the epidermis and/or the dermis for transplantation to a prepared wound bed. Patients requiring skin grafts often need anaesthesia and hospitalisation, and complications such as pain, infection and graft failure can result. This review will discuss the use of epidermal grafting (EG) as a skin grafting option, and present population groups that may benefit from its use.

The development of the CELLUTOME™ (KCl) epidermal harvesting system makes EG simpler and faster than traditional EG harvesting methods, allowing the procedure to be performed in an outpatient setting without anaesthetic. A discussion of the use of the epidermal device for two outpatient procedures will be presented, highlighting the importance of care of the graft to reduce the risk of failure. Both procedures resulted in a loss of the graft due to inexperience in EG wound management. A review of the evidence surrounding the effectiveness of EG is also discussed in this article; however, there remains limited quality evidence available for this novel approach to wound healing.

Introduction

Skin grafting is a wound management intervention for wound closure that involves removing and transplanting varying depths of the skin. Epidermal grafting (EG) has seen a resurgence as a grafting option thanks to technology which allows the procedure to occur in the outpatient setting. This review will discuss how EG works, the target population, and contraindications for its use in wound management, and examine the level of evidence to support its use in clinical practice. A brief discussion on first-hand experiences with EG will be presented, and recommendations for using the intervention will be suggested.

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Skin grafts

Skin grafting has been used for centuries as an option for closing a wound and involves harvesting the skin at depths that remove the dermis and epidermis[1]. EG involves the removal of the epidermis only, split skin graft (STSG) takes the epidermis and part of the dermis, and full thickness skin graft (FTSG) removes the epidermis and entire dermis from the donor site[1]. STSG and FTSG may require anaesthesia and a hospital admission to perform the procedure and can result in complications at both the donor and recipient site including pain, infection and poor cosmetic outcomes[2,3]. EG has been used successfully for covering granulating wounds and treating pigmentation disorders such as vitiligo, however its use in wound management has not been widespread due to the complicated and timely process involved in collecting the epidermis[4,5]. Recent technology has seen the introduction of the CELLUTOME™ epidermal harvesting device which has prompted a renewed interest in the use of EG for wound management. The device provides a means to perform swift harvesting of the epidermis in an outpatient setting without the need for anaesthesia[6].

Epidermal grafting

EG harvesting involves promoting blistering of the skin using negative pressure and heat so the epidermis is separated from the dermis[5]. Separation occurs at the lamina lucida, leaving the dermis untouched and, as a result, the donor site experiences nil or minimal bleeding, pain or inflammation[7,3]. Cosmetically, cleavage at this level allows the epidermis to regenerate without pigment changes nor scaring to the donor site[1]. EG contain keratinocytes, melanocytes, Langerhans cells, Merkle cells and epidermal stem cells that promote the production of epithelisation across the wound bed[5]. The transplanted keratinocytes migrate, proliferate and secrete extracellular matrix components, growth factors and cytokines that stimulate the wound bed and promote wound edge closure[8].

EG was traditionally achieved using syringes or suction cups connected to wall suction or vacuum pumps to

create blisters that were then removed by scissors or a scalpel[2,3]. The CELLUTOME™ epidermal harvesting system is a machine that applies heat and negative pressure to a small patch of skin, preferably an area with the least amount of sun damage such as the inner thigh, to create tiny blisters called microdomes[2]. Over a 40-minute period, heat is applied between 37–41˚C with 400–500mmHg of negative pressure to produce up to 128 microdomes in a 5x5cm area[9]. The raised blisters are then cleaved by the disposable harvesting device and transferred via an adhesive film or non-adherent silicon sheet onto the recipient site[5]. A bolster dressing such as negative pressure or compression bandaging is applied to hold the graft in place[5]. Epidermal growth spreads from the edges of the microdomes and healing or improvement of healing to the wound is expected within 2 months[10,11]. Cai et al.[4] discuss that donor site healing is achieved between 1–4 weeks.

Target population

EG has been presented in case series for treating acute wounds, surgical dehiscence, burns, chronic wounds, venous leg ulcers and diabetic foot ulcers[4,5,12]. Everts et al.[12] discuss the use of EG in stalled and chronic wounds such as dehiscence, venous leg ulcers and radiation ulcers that were, on average, 13 months old. Their case series presents results of wound closure on 66 of the 78 wounds included in the series, with 49 of the wounds healed under 3 months[12].

Howarth et al.[10] discuss the use of EG for spot grafting failed STSG areas in a burns patient. They report the case of a patient who sustained deep partial thickness burns to the shoulder and hand, and the closure of the exposed areas of the STSG failure using EG[10]. Joethy et al.[8] also discuss the use of EG on burns, focusing on patients with burns of a total body surface area of <10%. They present EG use on patients with varying depths of burns, and report closure of the wounds from 3–8 weeks with no visible scaring of the donor site after 2 weeks[8].

The ability to cleave the epidermis from the dermis minimises the inflammatory response and may be an option for grafting patients with inflammatory conditions such as pyoderma grangrenosum ulcers[13]. For patients that are on anticoagulation therapy, EG may be a safe option as the blood vessels in the dermis are not disturbed and risk of bleeding is minimal to the donor site[14]. Patients with multiple comorbidities and those who are a high surgical or anaesthetic risk may also benefit from EG, as anaesthesia and hospitalisation is not required[2,5]. Cai et al.[4] suggest that patients that are not candidates for STSG or FTSG due to donor site availability, healing capability or concordance issues may have success with an EG instead.

Contraindications

Any skin graft procedure involves assessing the ability of the recipient site to accept the transplanted skin. Contraindications include poor vascular supply, incomplete removal of malignancy, active infection and uncontrolled bleeding[15]. EG requires wound bed preparation to ensure the success of the graft, including a healthy granulating bed that is free from non-viable tissue and infection[1,16]. Highly exudative wounds and deep wounds without adequate granulation tissue are not recommended for EG[17].

Large wounds are also a contraindication for EG as a method of collecting large sheets of the epidermis has not been developed[18]. The EG harvester collects a grafting area of 5x5cm and multiple applications would be required to cover areas greater than 25cm^2 using this device[3]. The amount of donor site tissue available would therefore dictate how much of the recipient area can be grafted.

Evidence-based practice

Most research involving EG comes from case series, case reports or expert opinions and, in the last 5 years, the research is predominately from authors that are either employed or funded by the manufacturing company of the EG harvesting device. Available research involving the use of EG harvesting technology is therefore limited and usually involves conflict of interest and probable bias.

A systematic review and meta-analysis completed by Kanapathy et al.[19] was based on case series results as there were no randomised controlled trials (RCTs) available on EG. The recommendation from the meta-analysis is the need for RCTs and comparative research between EG and STSG[19]. Kanapathy et al.[20] have since published the EPIGRAAFT Trial, an RCT comparing STSG and EG on donor site morbidity and patient satisfaction. The RCT contained 44 participants and found no differences in healing time frames nor successful healing of the grafted wound between the two options[20]. The RCT reported that donor site healing was much faster using EG, with an average of 4 days to heal versus 21 days for a STSG[20].

CELLUTOME™ technology is unique on the commercial market and no similar devices are currently available. Some Queensland hospitals have the device, however the 2016 report by the Health Policy Advisory Committee on Technology (HealthPACT) does not recommend the use of the CELLUTOME™ technology in Australian public hospitals unless it is part of a clinical trial[9]. The HealthPACT recommendation was based on the finding that "No comparative studies were identified and, therefore, no conclusions as to the clinical effectiveness of the CELLUTOME™ system can be made"[9(p2)]. The report does acknowledge that the use of CELLUTOME™ may have clinical and financial benefits for managing wound healing. A review of the product was to be performed within 2 years, however no updates have been published on the HealthPACT website at the time of writing this article.

Clinical experience with EG

Post-procedure care for the donor site involves a simple

dressing covering such as a film to be reviewed weekly until healed[3]. For the graft, the case studies discuss the typical interface as a fenestrated transparent film or silicon to be used for transferring the blisters to the graft site which must not be disturbed for 1 week[11,13]. A secondary absorbent dressing is necessary to manage exudate and can be changed as required[21]. The dressings are held in place with negative pressure wound therapy (NPWT) or compression bandaging which will improve contact and protect the graft[21]. It may take up to 4 weeks before epithelial cells are visible, and care must be taken not to clean or debride the graft from the wound bed during this time[5].

Only two EG have been performed at my health facility to date, and on both occasions the grafts failed. In the initial case the recipient's wound bed was vigorously cleaned after the first week which removed all the microdomes. The second patient's graft was doing very well until week 3 when the wrapping was not removed from one side of the primary dressing, causing the wound to macerate and the graft to lift and fail. These errors highlighted a need for the same practitioner with knowledge of EG to attend the EG dressings until the graft was well established. A second round of EG was not attempted on either wound and both wounds healed eventually with standard wound care. The benefit from the experience was that both patients' donor sites were not visible 4 weeks after the procedure.

Despite the limitations in the research, the EG harvesting system is an alternative for skin grafting options in compromised patients. Both patients were unfit for anaesthesia, one due to age and one due to obesity. The grafting process took around 1 hour to complete the harvest, transplant the EG, and dress the graft and donor sites. The major benefit was the patients could go home immediately after the procedure, no anaesthetic was required, and neither patient reported any pain during the process.

Recommendations

EG gives an option for patients for wound closure that cannot have anaesthesia, and potentially provides another tool in the battle for healing chronic and stalled wounds. The success for the graft rests on wound bed preparation, not disturbing the wound bed for at least 4 weeks, and from having the same practitioner monitor and care for the wound to reduce the chance of accidentally removing the graft[5].

The evidence for using EG is not robust, with only one RCT available. Despite this, the author would recommend using the harvesting device on patients that have recalcitrant shallow wounds as its use may stimulate wound healing and, as all the case series suggest, minimal harm is associated with using the device.

Conclusion

EG involves removal and transplantation of the epidermis and relies on keratinocytes to stimulate wound closure in healthy and shallow granulating wounds. Recent technology allows EG to be performed in an outpatient setting in a timely manner with minimal pain or bleeding. It also provides an alternative grafting option for compromised patients. Poor recipient site vascularity, infection, non-viable tissue and limited donor site tissue are contradictions when considering an EG. Robust studies, including RCTs, are required to prove the effectiveness of EG, as most studies have a conflict of interest or financial affiliation with a manufacturing company. Despite this, EG does present a novel option for managing wound closure.

Conflict of interest

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References

1. Herskovitz I, Hughes OB, Macquhae F, Rakosi A, Kirsner R. Epidermal skin grafting. Int Wound J 2016;13(S3):52–6.
2. Fearmonti RM. Efficacy of epidermal skin grafts over complex, chronic wounds in patients with multiple comorbidities. Wounds 2016;28(7):226–32.
3. Osborne SN, Schmidt MA, Harper JR. An automated and minimally invasive tool for generating autologous viable epidermal micrografts. Adv Skin Wound Care 2016;29(2):57–64.
4. Cai SS, Gowda AU, Chopra K, Waldman R, Silverman RP, Rasko YM. A case series of complex recalcitrant wounds treated with epidermal grafts harvested from an automated device. Cureus 2016;8(10):1–11.
5. Hachach-Haram N, Bystrzonowski N, Kanapathy M, Smith O, Harding K, Mosahebi A, et al. A prospective, multicentre study on the use of epidermal grafts to optimise outpatient wound management. Int Wound J 2017;14(1):241–9.
6. Smith OJ, Edmondson S-J, Bystrzonowski N, Hachach-Haram N, Kanapathy M, Richards T, et al. The CelluTome epidermal graft-harvesting system: a patient-reported outcome measure and cost evaluation study. Int Wound J 2017;14(3):555–60.
7. Kanapathy M, Hachach-Haram N, Bystrzonowski N, Harding K, Mosahebi A, Richards T. Epidermal grafting versus split-thickness skin grafting for wound healing (EPIGRAAFT): study protocol for a randomised controlled trial. Trials 2016;17(245):1–6.
8. Joethy J, Koh K, Wong AW-J, Cheng A, Sellam S, Chong SJ. Initial impression of the CelluTome™ epidermal harvesting system in burns management. Burns Open 2019;3(2):68–74.
9. Ju H, Hassed P. Health policy advisory committee on technology: technology brief – CelluTomeTM epidermal harvesting system for the treatment of acute or chronic wounds. Hertson: Queensland Department of Health; 2016. Available from: https://www.coaghealthcouncil.gov.au/AHMAC/Health-Technology-Reference-Group/Reports-and-Briefs/Technology-Briefs-by-specialty
10. Howarth AL, Bell BE, Peterson WC, Renz EM, King BT, Chan RK. A novel approach to graft loss in burn using the CelluTome™ epidermal harvesting system for spot grafting: a case report. Burns 2015;41(6):e57–e60.
11. Vinceneux Talvande B, Carvalho Lallement P, Safa G, Journet Tollhupp J, Lembelembe JP, Blaise S, et al. Use of Cellutome for the healing of venous or mixed ulcers. Int Wound J 2018;15(6):993–9.

12. Everts PAM, Warbout M, de Veth D, Cirkel M, Spruijt NE, Buth J. Use of epidermal skin grafts in chronic wounds: a case series. Int Wound J 2017;14(6):1213–8.
13. Richmond NA, Lamel SA, Braun LR, Vivas AC, Serena T, Kirsner RS. Epidermal grafting using a novel suction blister–harvesting system for the treatment of pyoderma gangrenosum. JAMA Dermatol 2014;150(9):999–1000.
14. Parbhoo AV, Simpson MT. Suction blister skin grafting – a modern application. Br J Oral Maxillofac Surg 2014;52(3):283–4.
15. Prohaska J, Cook C. Skin grafting. StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2020.
16. Serena TE. Use of epidermal grafts in wounds: a review of an automated epidermal harvesting system. J Wound Care 2015;24(Sup4b):30–4.
17. Kirsner RS, Bernstein B, Bhatia A, Lantis J, Le L, Lincoln K, et al. Clinical experience and best practices using epidermal skin grafts on wounds. Wounds 2015;27(11):282–92.
18. Yadav S, Gupta S. Suction blister epidermal grafting. In: Gupta SK, Olsson MJ, Parsad D, Lim HW, Geel N, Pandya AG, editors. Vitiligo: Medical and Surgical Management [Internet]. John Wiley & Sons Ltd; 2018. p. 225-39.
19. Kanapathy M, Smith OJ, Hachach-Haram N, Bystrzonowski N, Mosahebi A, Richards T. Systematic review and meta-analysis of the efficacy of epidermal grafting for wound healing. Int Wound J 2017;14(6):921–8.
20. Kanapathy M, Bystrzonowski N, Hachach-Haram N, Twyman L, Becker DL, Richards T, et al. Lower donor site morbidity and higher patient satisfaction with epidermal grafting in comparison to split thickness skin grafting: a randomized controlled trial (EPIGRAAFT Trial). JPRAS 2020;73(8):1556–64.
21. KCI. Cellutome™ Epidermal harvesting system: epidermal harvesting automated, minimally invasive, and autologous epidermis. 2016. Available from: http://d46853ea57d10399291c-00624d9590ca0367cee1a170186bf36e.r14.cf2.rackcdn.com/cellutome/CEL-EPI-BRO.pdf