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January - April 2022

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Role of High Level Laser in Scar Management

Jacob Antony Chakiath[1], Ravi Kumar Chittoria[2]

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Abstract

Aim of this study was to assess the role of High level laser therapy like Er-YAG Laser in the management of scar. In our study, High level laser therapy like Er-YAG Laser helped in improving the scar which was objectively assessed by Vancouver scar scale(VSS) and clinical photography. The study shows that high level laser therapy like Er-YAG Laser therapy is an effective method in the management of scar.

Keyword: Laser; Scar; Vancouver scar scale.

INTRODUCTION

Scar management is a typical issue that people seek advice from a plastic surgeon about. Abnormal scars can be uncomfortable, itchy, and can make it difficult for the sufferer to move their joints, neck eyelids, or lips. Because of their location, colour, consistency, or size, scars can become ugly (height). Scars can be prevented and managed in a variety of ways. While scars cannot be totally avoided, they can be significantly improved with careful wound treatment. There is no one-size-fits-all approach to scar management. Scar massage with emollients, compression garments, intralesional steroids, surgical scar revision, and laser therapy are all common scar treatment techniques. Low-level laser therapy and high-level laser therapy are also available.

For many years, high-level laser therapy has been used; the first lasers used were CO2 and pulsed dye lasers.Because of the negative consequences, there is always a search for better and newer lasers that are equally effective but have less side effects and require less downtime to produce the desired therapeutic change. Alterations in size (height), consistency, colour (pigmentation), and vascularity are all desirable clinical changes that might make a scar less unattractive.[1]

Though the Erbium YAG (Er-YAG) laser has been utilised in western countries for many years, it is a relatively new addition to the scar treatment arsenal in India, hence research on its success in treating unattractive scars in Indian skin types is

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limited. We used the Er YAG laser for fractional ablative resurfacing of post burn scars in this study, and we investigated the influence of the laser on each scar parameter.

MATERIALS AND METHODS

This study was conducted in the Department of Plastic Surgery at a tertiary care center after getting the departmental ethical committee approval. Informed written consent was taken from the patient for Er YAG therapy as well as the clinical photography (Fig. 1). The subject was 22yr old female with post burn scar on her face caused by an accidental kerosene flame burn 20yrs back. The scars were evaluated twice using the Vancouver scar scale scoring system and clinical photography twice once pre-treatment and next one month after the completion of the laser therapy. The laser therapy was given for four sessions each at a one-month interval (Fig. 2). The laser used was Er: YAG Laser, Twain 2940, Quanta System S.p.A., Italy, in ablative as well as thermal mode, at a wavelength of 2,940nm, fluence was set to 1 to 2 J/ cm2, pulse width used was 300 microseconds using spot diameter of 4mm. During each session, two laser passes of 400 mJ in short pulse mode (pulse duration 0.30ms) and one pass of 800 mJ in long pulse mode (pulse duration 1 ms) were performed. Post-therapy VSS score and clinical photography results were analyzed.

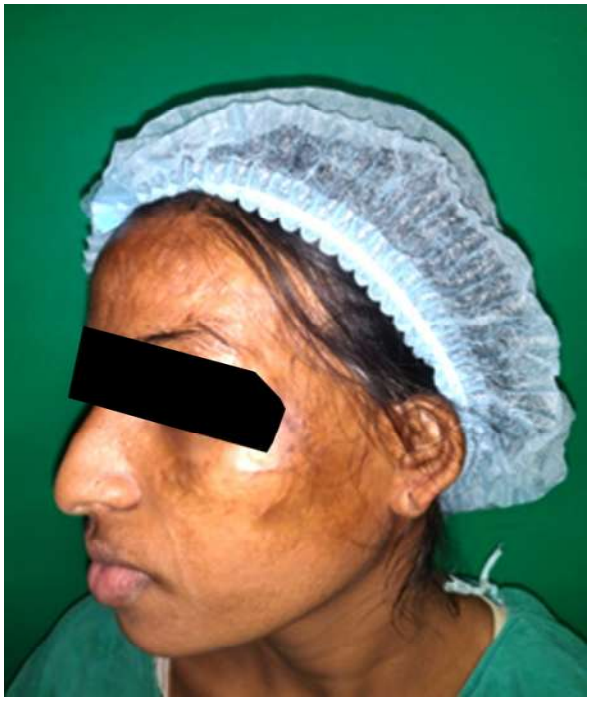

Fig. 1: Pre procedural.

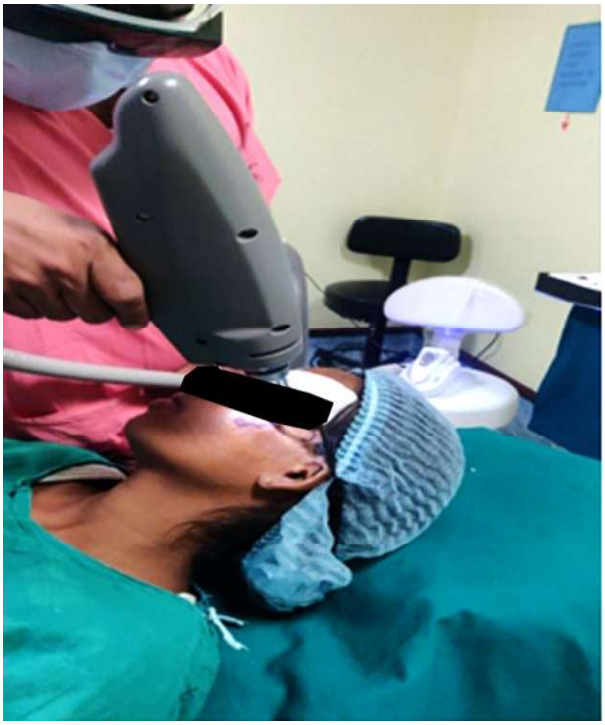

Fig. 2: Er-YAG laser therapy.

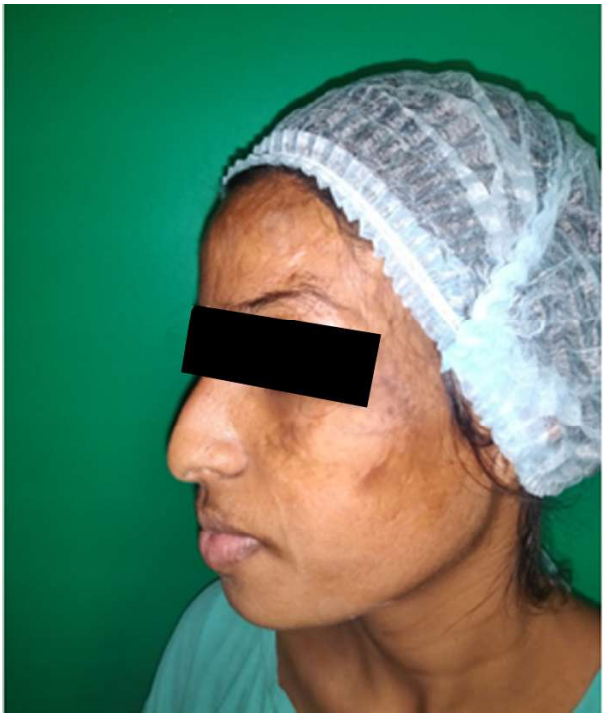

Fig. 3: After four sessions of Er-YAG each at a one-month interval.

RESULTS

The pre-procedural and post-procedural Vancouver

scar scale(VSS) parameters are comparisons showed that there was a significant difference after laser application. The pre-procedural VSS score was 5/13. The post-procedural VSS score was 2/13. Post therapy clinical photograph also showed improvement.

DISCUSSION

After an injury or disease, the scar is defined as fibrous tissue that replaces the wound. During the healing process, the wound produces a collagen fibre bridge with a thin epithelium, resulting in an immature scar.[2] An juvenile scar is red, elevated, hard, and hypopigmented. As the scar matures, it becomes more flexible, flatter, and less vascular, and its colour returns to normal. Any deviation causes the scar to be unnatural or ugly. The difference in extracellular matrix composition between a normal scar, an immature scar, and a hypertrophic scar is that Type-III collagen is prevalent during the proliferation phase of normal wound healing and is subsequently replaced by Type-I collagen during the remodelling phase. A developed scar is composed of 80 percent type-I collagen, 10-15 percent type-III collagen, and a little amount of type-V collagen. An aberrant scar has a different composition, with a higher ratio of type-III to type-I collagen. Around 33% type-III collagen, 10% type-V collagen, and around 60% type-I collagen make up the atypical scar.[3] In addition to the collagen composition, the organisation of fibrils and interfibrillar space in an aberrant scar differs from that of a mature scar.In an aberrant scar, the cellular function of fibroblasts and keratinocytes is also changed, rendering them profibrotic. In an aberrant scar, the expression of cytokines is also changed.

The balance between matrix metalloproteinases (MMPs) and tissue inhibitors of metalloproteinases (TIMPs) has shifted in favour of profibrosis. TGF-ß, connective tissue growth factor (CTGF), plateletderived growth factor (PDGF), and insulin-like growth factor 1 (ILGF-) are upregulated, while interferon (IFN-) and interferon (IFN-) are downregulated.

Maimon invented the first LASER machine in 1960, which was a Ruby laser. Dermatologist Dr. Leon Goldman is known as the "Father of Laser Medicine." Pulsed Dye Laser (PDL), which was utilised for port-wine stains, was the first laser that was particularly intended for use in a medical condition. Since then, more concepts such as pulsed therapy, fractionated laser therapy, Q-switched mode, and others have been added to the list. Any laser works on the principle of photothermolysis, which was initially postulated by Anderson.[4]

Each laser has a chromatophore, which is a specific target on which it functions. The laser acts on its chromatophore selectively, causing thermal ablation of the target tissue. Fluence, pulse width, spot size, and stacking are variables that must be modified to meet the needs of each individual. The mechanism by which a laser influences scar remodelling is unknown, however ablative fractional resurfacing may stimulate a range of not-yet-understood cellular responses, resulting in the creation of different cytokines and growth factors. Fractional photothermolysis causes controlled and limited dermal heating, which sets in motion a chain of events that leads to the normalisation of the collagenesis-collagenolysis cycle.

The Vancouver Scar Scale (VSS) was used to compare the results. Characteristic includes vascularity, pigmentation, Pliability, Height. Total score out of 13. The clinical photograph was also used for comparison.

CONCLUSION

The study shows that high level laser therapy like Er-YAG Laser therapy is an effective method in the management of post-burn scar. The pigmentation and height of the scar showed significant improvement after the application of the Er YAG Laser. No adverse effects were noted during the study. Large volume and multi-center study may give a better picture of the effect of Er YAG laser.

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Complications of Microdermabrasion in Scar Management

Chandavaram Bhanu Prakash[1], Ravi Kumar Chittoria[2], Jacob Antony Chakiath[3]

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Abstract

Scars such as hypertrophic and Keloid scars are still among plastic surgery's worst nightmares.Other scars which we have consider are those of burns scars, which can result in ugly appearance and cumbersome to patient. But they too found to have some complications. This provides an overview of scars and scar contractures, and management principles especially microdermabrasion and complication developed with it. In our study we have observed maceration after 2 days of procedure.

Keywords: Microdermabrasion, scar.

INTRODUCTION

Scar quality varies greatly depending on the patient's personal and racial characteristics, the type of trauma, and the condition of wound healing.[1] Management of scars is an important issue that to be addressed in current part of world.[2] Microdermabrasion is one of the recent models that has been proposed in management of scars. The application Microdermabrasion (MDA) demonstrate a considerable improvement in postoperative scar avoidance.

MDA has also shown to effect deeper layers of epidermis and dermis. MDA causes a rearrangement of melanosomes in basal layer of epidermis, flattening of Rete ridges of dermoepidermal junction. Microdermabrasion is a procedure in which stratum corneum layer, outer most layer of epidermis are removed and allowed to heal by secondary intention.[3]

Many new techniques are coming up toward the treatment of scars, among which Microdermabrasion application is gaining look towards them. But it too found to have some complications. So it is important to study about the complications of Microdermabrasion.

Microdermabrasion is also recently being used in acne scar management. There are various ways of Microdermabrasion among which crystalline hydrogen Microdermabrasion and diamond hydrogen Microdermabrasion are used commonly.[5]

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MATERIALS AND METHODS

This was done in a tertiary care hospital in south part of India after receiving approval from departmental ethics committee. The subject is a 40 yr old male with post necrotizing soft tissue infection of right leg and foot. On examination an ulcer is present on right leg extending from knee anteriorly and popliteal fossa posterior to dorsum of foot up to base of toes, irregular in shape, margins are sloppy, granulation tissue present, surrounding skin normal. Previously he was treated with multiple sittings of hydro jet debridement, phototherapy, insulin therapy, Low level laser therapy, autologous platelet rich plasmaand heterograft, negative pressure wound therapy (Fig. 1) and after that scar management was started. Microdermabrasion was done for scar management.

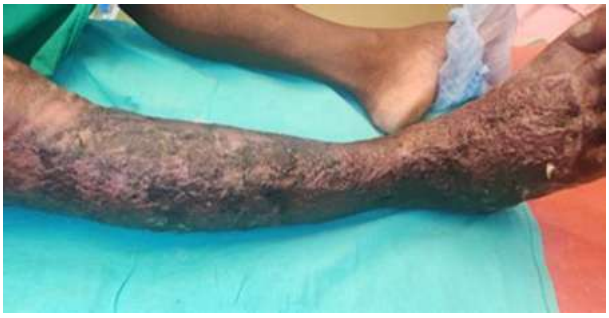

Fig. 1: Healed wound with scarring.

Step 1: Make wound free of infection.

Step 2: Wound management up to granulation tissue cover completely.

Step 3: Do Microdermabrasion (Figure 2).

Step 4: Look for complications.

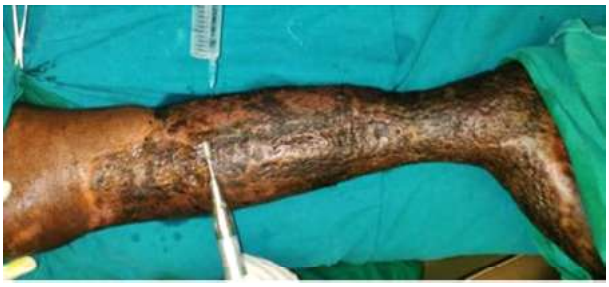

Fig. 2: Application of Microdermabrasion for Scar

RESULTS

Observing day by day will help us to know any complications with Microdermabrasion. On third day of doing Microdermabrasion, we have observed maceration (Fig. 3) of skin at wound area. After that we have removed the dressing and treated with antibiotics and regular dressing (Fig. 4). Therefore maceration of skin can be considered as a side effect of Microdermabrasion.

Fig. 3: Maceration seen after Microdermabrasion

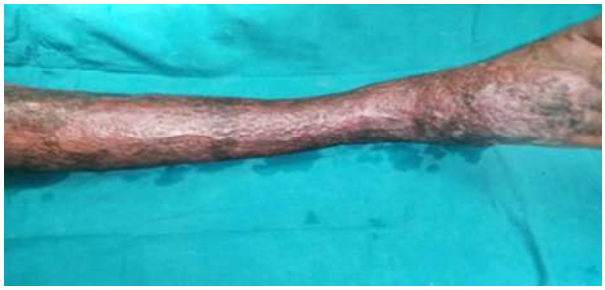

Fig. 4: Complete Healing of Maceration after Antibiotics.

DISCUSSION

Scar management is an important step in management of wound. Patients of post-burn contractures, defects and disfigurements will be most of patients whom plastic surgeons deal with in government institutions. Microdermabrasion has been shown to be useful in scar control; however it does have certain drawbacks. Scars are to be repaired as they can give ugly appearance and sometimes restriction of daily activities. So it is better to know about new techniques and complications associated with them.

Microdermabrasion has been seen as an upcoming technique in treating scars. So we should study about the complications associated with it. After doing Microdermabrasion we have observed the skin maceration after 2 days. Then it was resolved with antibiotic dose and regular dressings.

CONCLUSION

Skin maceration has observed with Microdermabrasion procedure. It was resolved with antibiotics and regular dressings. Skin

maceration can be considered as a complication of Microdermabrasion.

Conflicts of interest: None

Financial Disclosure: None

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Skin Substitutes: An Overview

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Abstract

Skin substitutes are a heterogeneous group of biologic, synthetic, or biosynthetic materials that can provide coverage of open skin wounds. The aim of skin substitutes is to replicate the properties of the normal skin. Biocompatibility, antimicrobial activity, appropriate hydrophilicity, and biodegradability are all desirable qualities in a skin substitute. The goal of tissue engineering research is to develop cell-based wound substitutes or wound covers that promote cell migration, differentiation, and vascularization to facilitate wound healing.

Keyword: Skin substitute.

INTRODUCTION

The biggest organ on the human body, the skin defends the body from the elements. The loss of the skin barrier's integrity as a result of injury or deformity can result in serious problems or even death. After skin damage, large and deep skin wounds do not heal in a timely manner.[1]

Skin substitutes are a heterogeneous group of biologic, synthetic, or biosynthetic materials that can provide coverage of open skin wounds. The aim of skin substitutes is to replicate the properties of the normal skin. Biocompatibility, antimicrobial activity, appropriate hydrophilicity, and biodegradability are all desirable qualities in a skin substitute.

In this Article, we explain commercially available skin substitutes for different clinical applications. We also call attention to the recent use of 3D bioprinting technology to create cell-based skin substitutes.

BACKGROUND

Various circumstances can cause skin integrity to be compromised, resulting in a variety of wounds, including acute and chronic wounds. Wounds can also be divided into mechanical injuries such as abrasions and tears produced by external forces, and skin injuries induced by radiation, electricity, corrosive chemicals, and thermal sources causing severe burns.[2]

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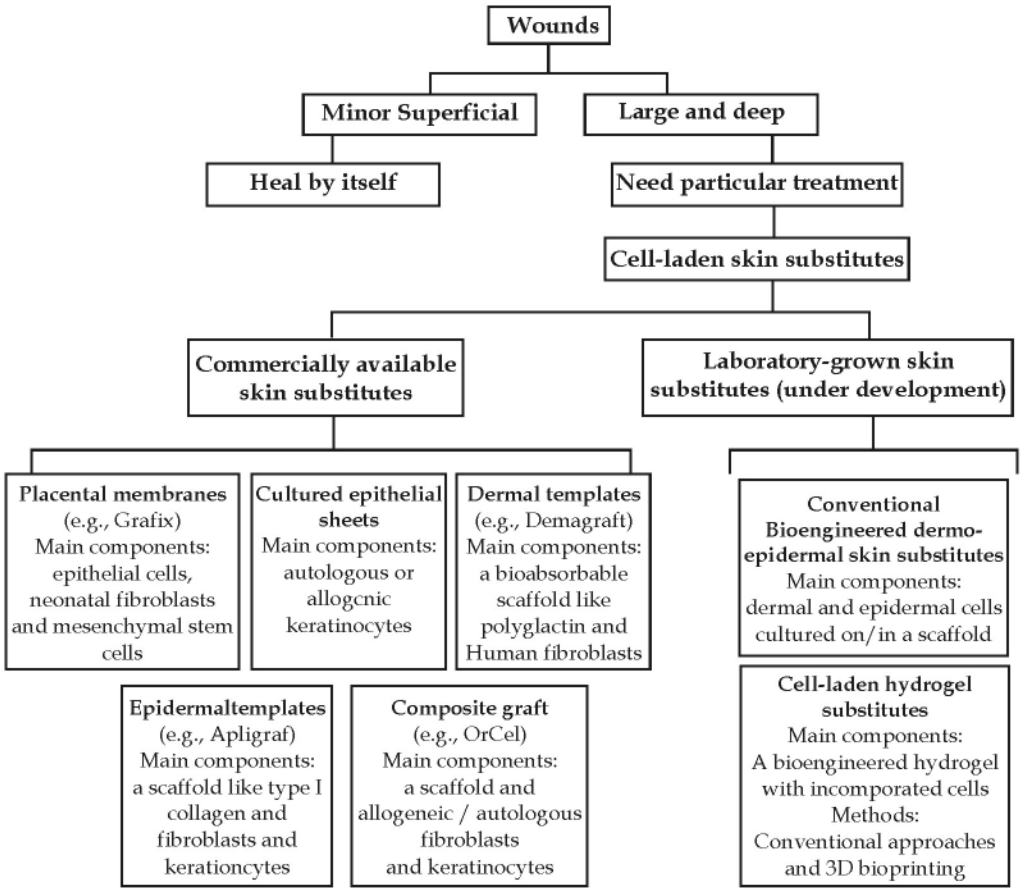
Minor superficial skin lesions can be healed through epithelialization in the human body without any special therapy. Large and deep skin flaws, on the other hand, necessitate skin replacement in order to heal effectively.[3] Hard-to-heal chronic wounds, impaired vascularization is the main cause of delayed healing.

The goal of tissue engineering research is to develop cell-based wound substitutes or wound covers that promote cell migration, differentiation, and vascularization to facilitate wound healing. The bulk of cell-based skin substitutes are made up of a scaffold that is seeded/cultured with cells.[4]

CLASSIFICATION



CELL-LADEN COMMERCIAL SKIN TEMPLATES

Placental Membranes

Epithelial cells, neonatal fibroblasts, and mesenchymal stem cells (MSCs) in the placental membrane, aid wound healing. MSCs secrete substances that encourage the migration and proliferation of the many cell types involved in wound healing.[5] Hepatocyte growth factor (HGF) and vascular endothelial growth factor (VEGF) are released by MSCs to promote vascular network creation and anti-scarring capabilities, respectively.[6]

Grafix (Osiris Therapeutics Inc., Columbia, MD, USA) is a placental-based cryopreserved allograft that is commercially accessible. It's used to treat diabetic foot ulcers, epidermolysisbullosa, burns, and surgical incisions and dehiscence, among other acute and chronic wounds.[7]

Cultured Epithelial Sheets (CEA)

CEA is made up of either the patient's own keratinocytes (autologous) or donor cells (allografts), which are sheets made from the skin of a stranger. Large burn injuries and persistent ulcers can both benefit from this treatment. Donor skin is limited in burn wounds that cover more than 50% of the total body surface area.[8] As a result, cultivated epithelial autografts may provide covering to aid wound closure. Due to its uneven graft take rates, infection risk, and frequently disappointing

functional and cosmetic results, CEA's application potential is restricted. The lack of a functionally competent dermal component is the primary cause of these issues.[9]

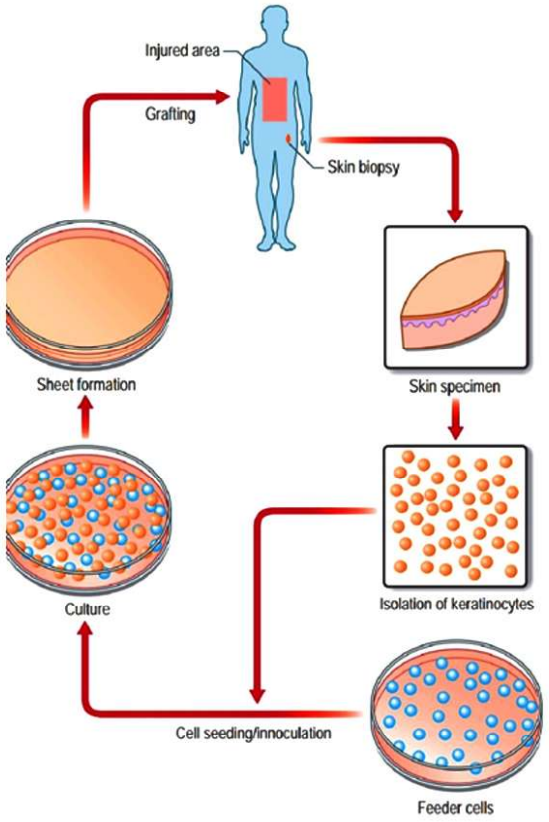


Fig. 1: Keratinocyte culture.

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Dermal Templates

Dermagraft is a dermal substitute made up of allogeneic human fibroblasts in a polyglactin scaffold (Smith and Nephew, Largo, FL, USA). It comes frozen in a transparent bag with one piece for a one-time use application. It can be used for lengthy periods of time to treat full-thickness diabetic foot ulcers as well as deep necrotic cutaneous ulcers that do not involve the tendon, muscle, joint capsule, or bone.[10] There are no macrophages, lymphocytes, blood vessels, or hair follicles in dermagraft.[11]

Epidermal Templates

The development of a stratified keratinocyte layer to provide barrier function, is critical focus of epidermal tissue engineering.[12] It acts as a physical scaffold for cell migration and release of soluble substances like chemokines and growth factors.[13] Apligraf (Organogenesis Inc., Canton, Massachusetts, CA, USA) is a bilayered bioengineered skin replacement (BBSS) that mimics the normal structure of human skin by combining a bovine type I collagen lattice with a dermal layer of human fibroblasts and a layer generated by human keratinocytes.[14]

Dermo-Epidermal Skin Equivalents (Composite Graft)

Composite allografts that contain both major skin layers (dermis and epidermis), closely replicating the form and function of normal human skin tissue. In comparison to dermal substitutes, one of the major advantages of composite grafts is their one-step application technique.[15] Many bioengineered commercial composite skin grafts are available likeAlloskin (AlloSource, Centennial, CO, USA) & OrCel (Ortec International, Inc., New York, NY, USA).

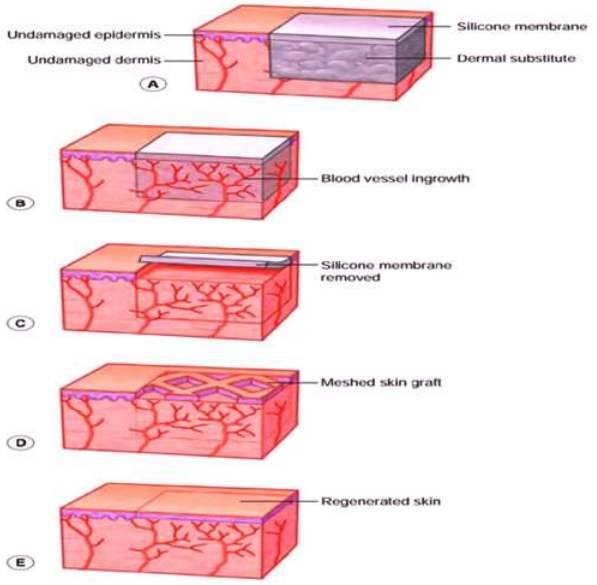

Fig. 2: Skin regeneration with dermal substitutes (Integra)

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BIOENGINEERED DERMO-EPIDERMAL SKIN SUBSTITUTES

(Under Development)

Split and full thickness skin autografts, as well as skin flaps, skin expansion procedures, and dermal replacements, are the "gold standard" approaches for covering such skin abnormalities. For patients with severe, full thickness skin injuries, laboratory-grown skin substitutes offer a fresh, potential therapy alternative.[16,17]

Cell-Laden Hydrogels as Wound Dressings

The most common materials used as a scaffold for culturing cells for skin healing applications are hydrogels. Because of their 3D matrix, which is rich in water, and their biodegradability, hydrogels can be used as a scaffold for cell encapsulation. Moreover, the vast majority of them are biocompatible.[18,19,20]

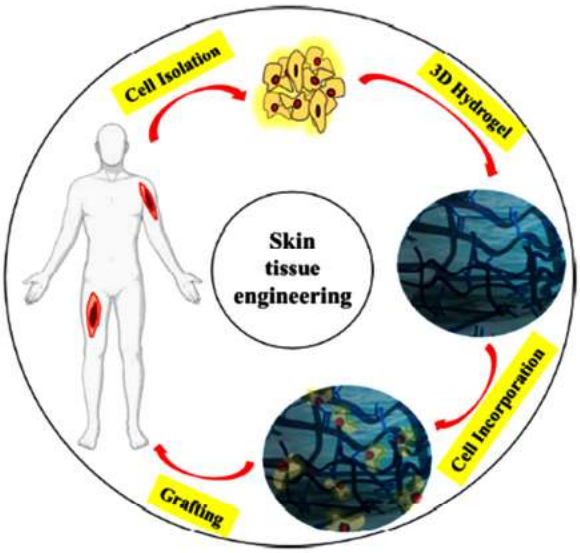

Fig. 3: Schematic representing the preparation process of a cell-laden hydrogel in which cells from an isolated donor are placed and then cultured in a 3D hydrogel matrix and grafted to a skin defect as a skin substitute.

Porous hydrogels are bioscaffolds that include cells, generate a foam or crosslinked hydrogel that can be used as a skin substitute on a wound. Porosity, in particular, is significant because it allowed host cells to infiltrate the 3D network and improving protein transport and diffusion to imitate native tissue structure.[21] The ideal pore size for fibroblast ingrowth is 5–15 m, 20 m for hepatocyte ingrowth, and 20–125 m for adult mammalian skin regeneration.[22,23]

Stimuli-responsive hydrogels, When activated by various internal or external stimuli, the encapsulated cells and biomolecules are released into the host tissue. The development of a cell/ hydrogel scaffold structure in situ allows for the transfer of encapsulated cells, growth factors, and essential nutrients to the wound site via minimally invasive procedures.[24]

In the study conducted by of *Eke et al* [25], to stimulate vascularization in difficult-to-heal wounds, a UV-crosslinked biodegradable hydrogel was used as a scaffold containing adipose-derived stem cells (ADSCs). The hydrogel network was created using methacrylated gelatin (GelMA) and methacrylated hyaluronic acid (HAMA) in this study. After that, a photoinitiator and cells were added to the pre-hydrogel solution at the same time to induce photo-crosslinking.[25]

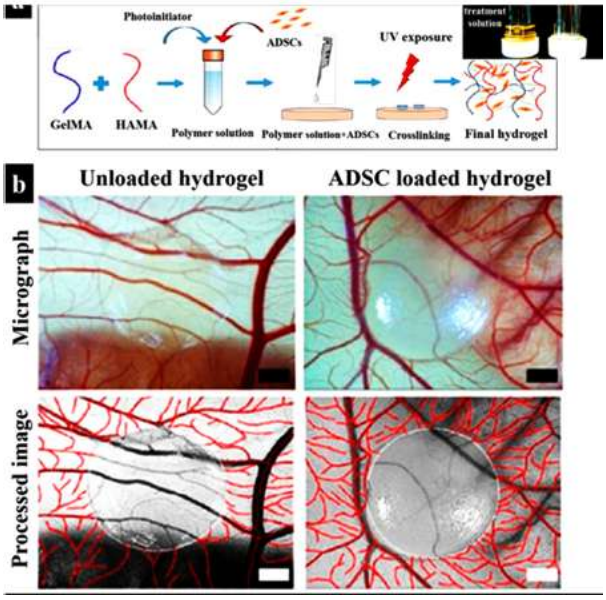

Fig. 4: Schematic demonstrating methacrylated gelatin (GelMA) acid methacrylated hyaluronic acid (HAMA) chain integration to prepare polymer solution. Furthermore, the addition of photoinitiator to prepare a UV-crosslinkable hydrogel containing adipose-derived stem cells (ADSCs) to produce a cell-laden hydrogel wound 25.

3D Bioprinting of Cell-Laden Hydrogels for Wound Dressings

A new fabrication technology for cell-laden hydrogels is 3D printing. This technique comprises layer-by-layer printing of hydrogel with cells to create a complicated bioscaffold.[25] The capacity to produce therapeutically relevant skin constructs that closely replicate native skin architecture and heterogeneity is the main benefit of this technology in skin engineering. However there are a variety of hydrogels used in bioprinting, natural polymers such as alginate, collagen, gelatin, fibrin, and hyaluronic acid are the most common.[26,27]

Several studies have shown that a human-plasma derived bilayered skin used for the treatment of burn injuries and traumatic and surgical wounds. other ones are Neonatal human epidermal keratinocytes (NHEKs) and neonatal human dermal fibroblasts (NHDFs), both embedded in a fibrin–collagen hydrogel matrix known as Apligraf.[28] In These studies, wound-healing behaviour of the control (no therapy) and Apligraf

(described previously) groups were compared. Wounds treated with printed substitutes took 14–16 days to heal, compared to 21 days for the control group and 28 days for the Apligraf group.[29] Furthermore, histological analysis revealed the production of dermal and epidermal skin layers that are equivalent to native skin, as well as the appearance of new microvessels in mouse tissue.[30]

Other recent research projects have focused on producing cell-laden hydrogel bioinks to print skin layers or substitutes, with natural hydrogels as the focus. A suitable hydrogel bioink should be cell friendly and capable of incorporating/ encapsulating cells both before and after crosslinking. To create adequate cues for cells to differentiate and proliferate, the bioink hydrogel should resemble the physical and mechanical properties of original skin after printing.[31,32]

An Ideal skin coverage should not only protect the wound and promote tissue regeneration, but it should also improve the aesthetics, satisfaction, and welfare of the patients. As a result, significant progress has been made in the field of skin tissue engineering in recent years. To identify the ideal skin replacement for use in acute and chronic skin wounds, many skin substitutes based on synthetic or natural scaffolds, as well as bioengineered skin replacements, have been created.3D bioprinting has evolved as a practical way for fabricating skin substitutes from primary cells derived from the patients' own skin cells.

These various techniques to developing newer skin substitutes provide new optimism that the optimal skin substitute may be developed shortly.

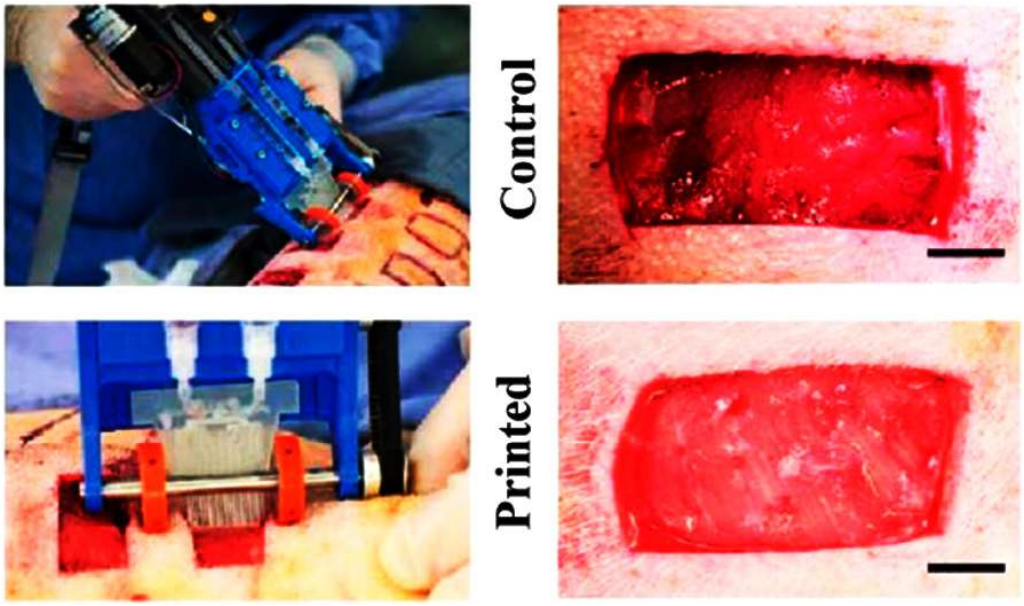

Fig. 5: Handheld skin printer. Above image shows in situ deposition of a fibrin–hyaluronic acid/ collagen sheet on top of a full-thickness excisional porcine wound using a handheld skin printer. (top) Close-up view of sheet formation within wound bed with a 2 cm microfluidic cartridge (bottom)[32]

Table 1: Explain the available permanent and temporary dermal & epidermal grafts.

Product	Tissue-Cells	Manufacturing Avilability	Origin
Epicel® (Genzyme MA)	Epidermis Cultured Epidermd Autograft (CEA) Sheets	Tissue Cultures Expanded In The Labortory Our Several Weeks	Autologous And Exnoogenic (Residual Amounts Pf Murine Cells
Recell®(Avita Medical,UK)	Epidermis -Autologous Epicermal Cells Dermisfibroblasts; Cells Suspension, Dilvered With Spray	Bedside Approach (About 30 Minutes Required)	Autologous
Cellutone®Epidermal Harvesting System (KCI, TX)	Epidermis-Autologous Epidermal Islands Delivered On A Dressing	Bedside Approach (About 60 Minutes Required)	Autologous

Integra® (Integra Lifesciences, NJ)	Dermis-Bovine Tendon Type I Collagen And Glycosaminoglycans On A Silicone	On The Shelf	Autologous
Matriderm® (Medskin Solutions Dr. Sewelack, Germany)	Dermis-Bovine Acellular Non-Crosslinked, Coated With Elastin	On The Shelf	Xenogeneic
Alloderm® (life Cell Coporation, NJ)	Dermis-Human Acellular Lyophilized Cadaver Dermis	On The Shelf	Allogeneic
Dermagraft® (Organogensis, MA)	Dermis-Human Fibroblasts On Polyglycolic-Polylactic Acid Mesh	On The Shelf	Allogeneic
EZ Derm (Molnlycke Health Care, Sweden)	Dermis-Porcine Aldehyde Cross-Linked Dermal Collagen	On The Shelf	Xenogeneic
Oasis® Matrix (Smith And Nephew, TN) Allograft	Dermis-Porcine Acellular Small Intestine Submucosa. Composite -Cryopreserved Cadaveric Skin	On The Shelf	Xenogeneic
Apligraf® (Organogenesis, MA)	Composite-Neonatal Human fibroblasts In Bovine Type I Collagen Neonatal Human Keratinocytes	On The Shelf	Allogeneic / Xenogeneic

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