

Thin Loaded Material-Based Composite Scaffolds Potential Healing of Chronic Wounds

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UNIVERSITY of
GREENWICH



INTEGRATING
Delivery Science
ACROSS DISCIPLINES



Our Three Campuses



Famous Filming Site



Greenwich

The university's largest campus, Greenwich has three 17th century buildings designed by Sir Christopher Wren.



Medway

A recently modernised Edwardian redbrick and ivy-clad campus at Chatham maritime, Kent.



Avery Hill

This campus in Eltham combines the grace of a Victorian mansion with modern living and teaching facilities.

Outline

Background

Case Study

**Composite
Alginate-Collagen-Hyaluronate
Scaffolds**



Conclusions

**Potentially
Distressing
Images**

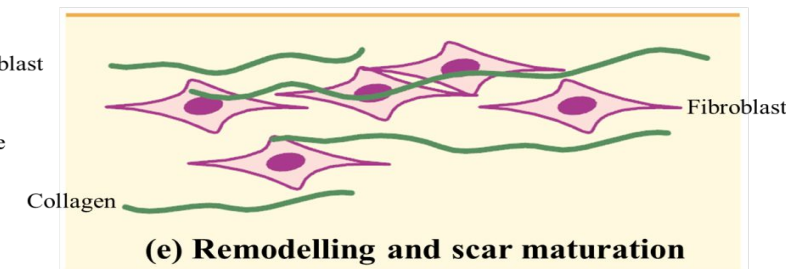
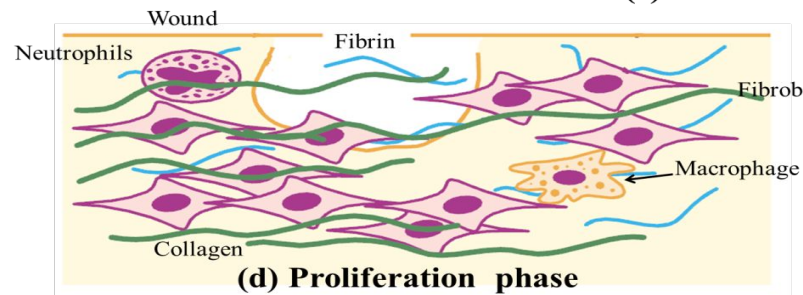
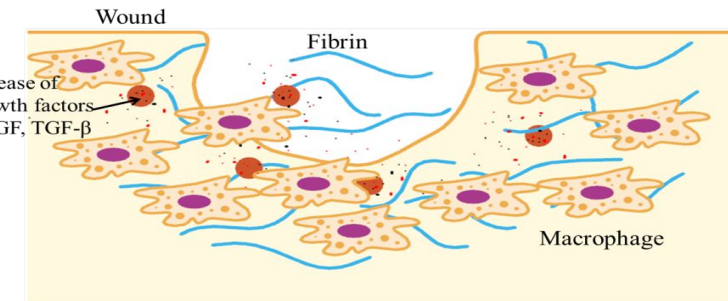
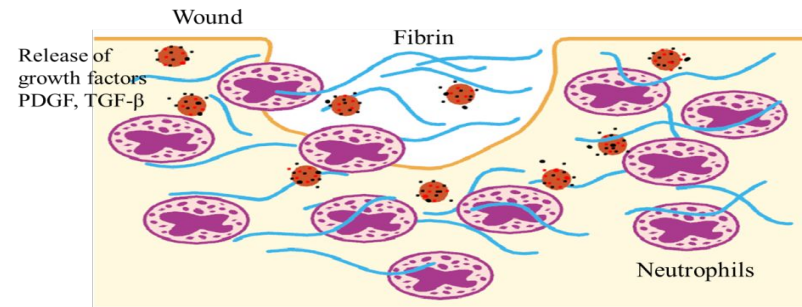
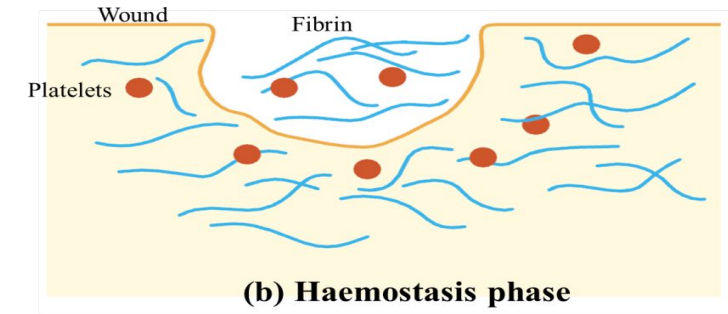
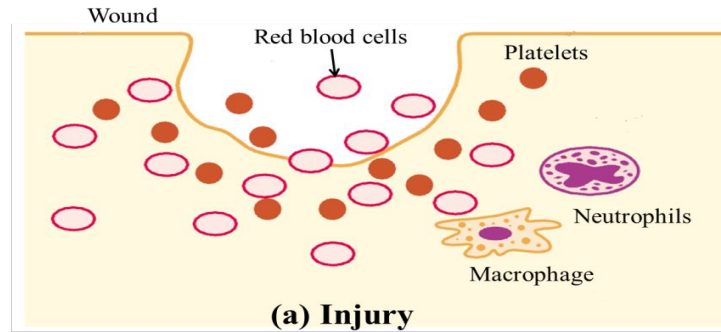
Acknowledgments



Background

Wound Healing is a **Complex Process**

- ❖ Several biochemical and physiological activities
- ❖ Different stages of wound healing
- ❖ Alterations in any phase can cause impaired healing



**Most dressings
target only one
healing phase**

**Biologically
inactive
(passive healing)**

Challenges & Needs

**Depend on
normal body
function to heal**

**No single
dressing meets
all 'Ideal'
characteristics**



Advanced Solutions

Tissue Engineered Skin Substitutes

- ❖ Significant tissue loss
- ❖ Effective / **Expensive**



Skin Grafts

- ❖ Significant tissue loss
- ❖ Creation of another wound (**painful**)
- ❖ Effective / **Expert Personnel** / **Expensive**

Biological Dressings

- E.g. **Collagen***, **Hyaluronic acid***
- Natural skin matrix

Medicated Dressings

- Analgesic / anti-inflammatory - pain
- Antimicrobial - infection
- **Growth factors to actively aid tissue regeneration***

Natural Products

- Honey, Plant Extracts

Previous Results

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Composite Fish Collagen-Hyaluronate Based Lyophilized Scaffolds Modified with Sodium Alginate for Potential Treatment of Chronic Wounds

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Abstract

Chronic wounds are characterized by both decreased collagen deposition and increased collagen breakdown. It is

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Objectives

Crosslink HA within composite SA-FCOL-HA scaffolds to enhance functional performance for chronic wound healing

Use as platforms for delivering GFs directly to take active part in the wound healing process



Scaffold Design & Development

- Sodium alginate (SA), fish collagen (FCOL) and hyaluronic acid (HA)-based gels prepared
- HA crosslinked by PEGDE in the presence of IT and freeze-dried to obtain porous scaffolds

Formulations	Polymer weight ratio	Constituent amount (mg)				
		SA	FCOL	HA	IT	PEGDE
2.0% SA: FCOL: HA	3:4:1	750	1000	250	250	500
2.0% SA: FCOL: HA	1:2:1	500	1000	500	500	1000
2.0% SA: FCOL: HA	1:1:2	500	500	1000	1000	2000
2.0% SA: FCOL: HA	2:3:3	500	750	750	750	1500
2.0% SA: FCOL: HA	1:2:5	250	500	1250	1250	2500
2.0% SA: FCOL: HA	0:3:5	0	750	1250	1250	2500



Characterization

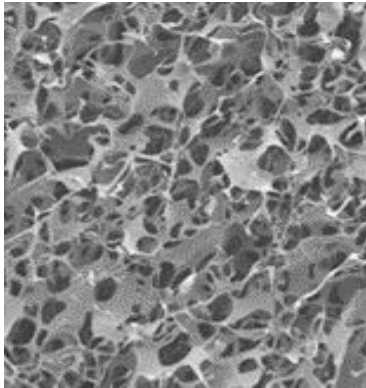
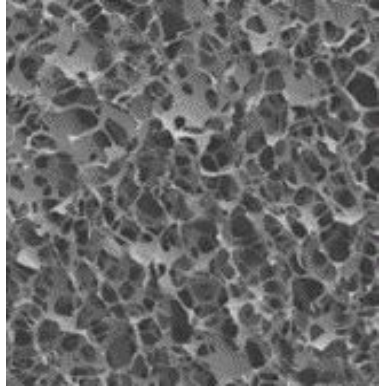
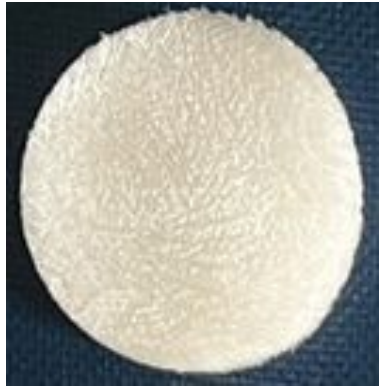
NMR and GPC confirmed crosslinking

Texture analysis (hardness and adhesion)

Scanning electron microscopy

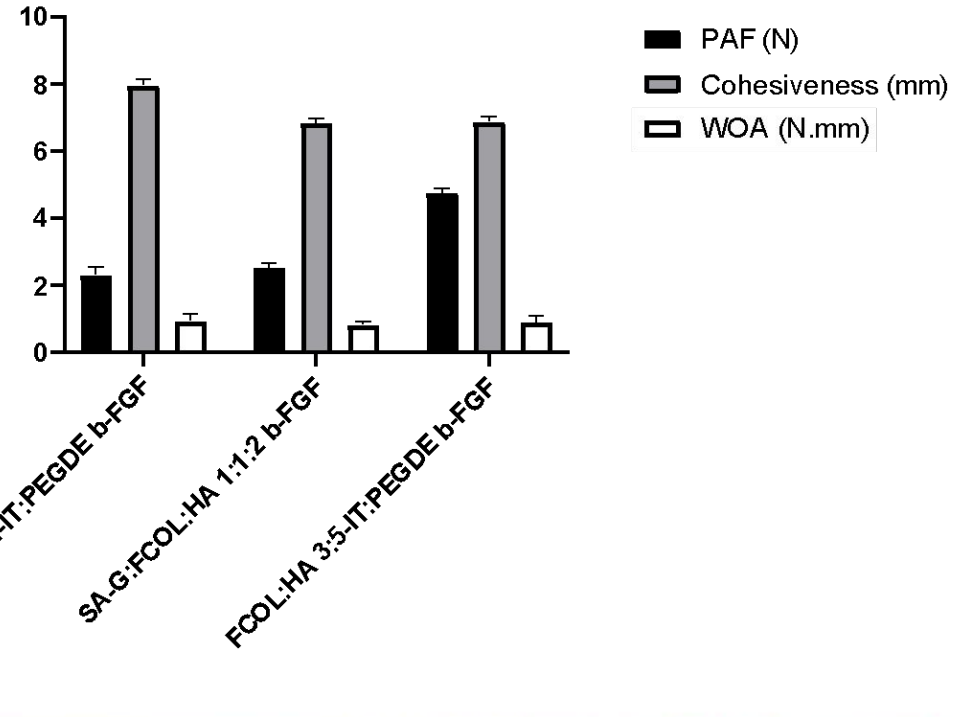
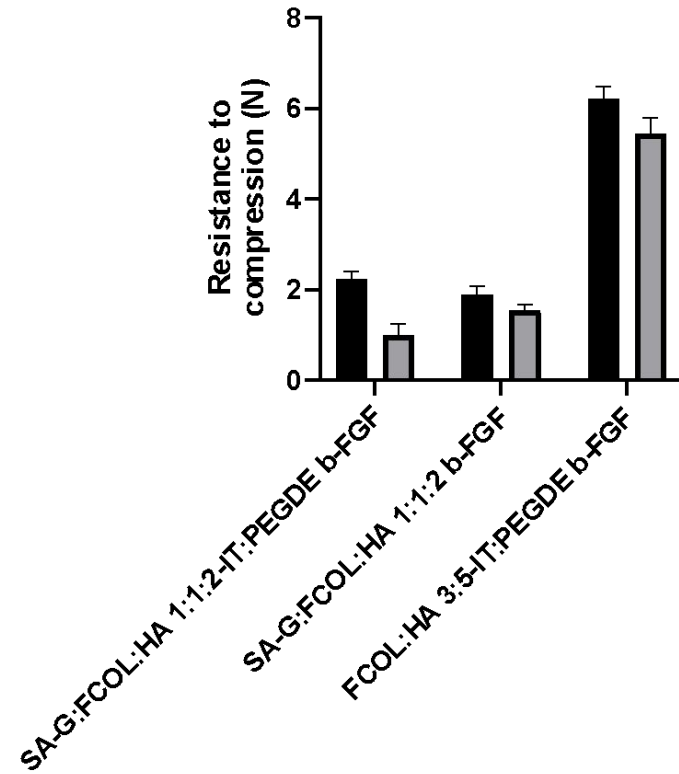
Porosity, swelling capacity, gel strength

- **Exudate handling**
 - ❖ **Water vapor transmission rate**
 - ❖ **Equilibrium water content**
 - ❖ **Water absorption**
 - ❖ **Evaporative water loss**
 - ❖ **Drug release**
- **MTT assay (cell viability)**
- **Coagulation effect**
- **Scratch assay**



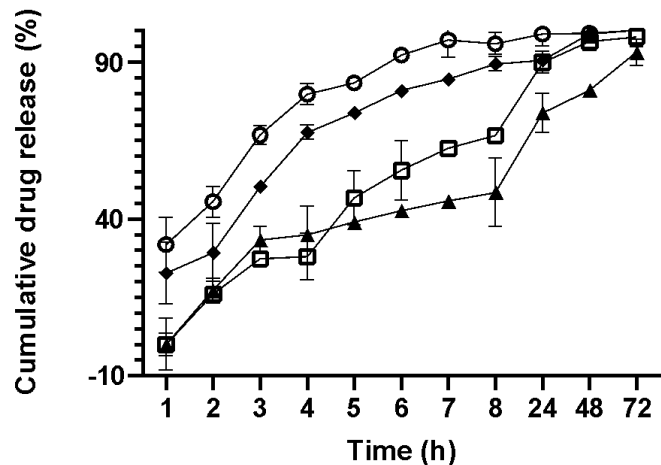
**SA:FCOL:HA
1:1:2**

**SA:FCOL:HA
1:1:2 FGF**



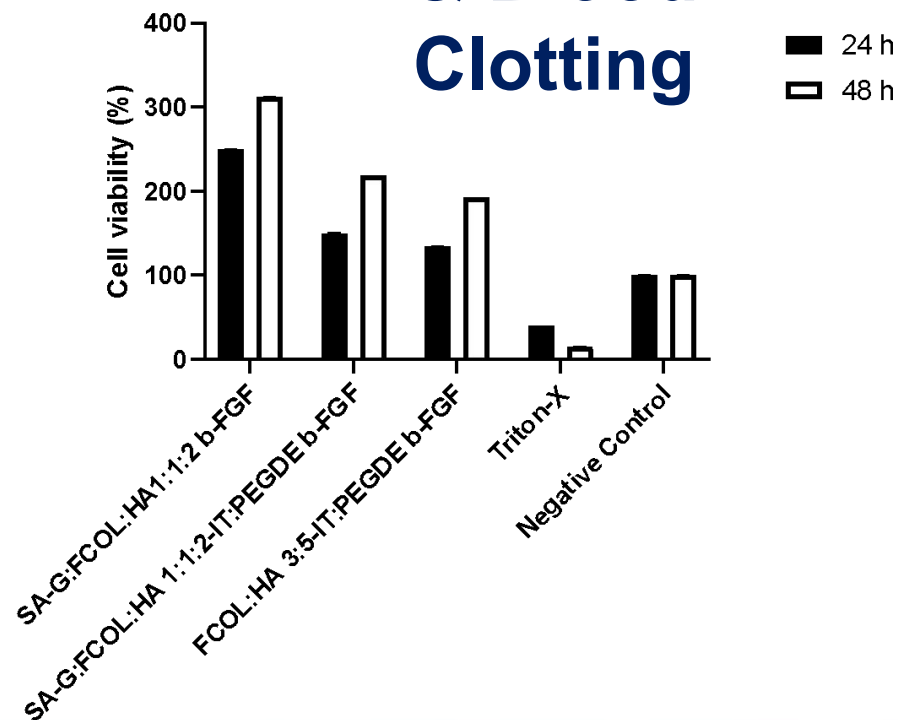
Sample name	Porosity (%) ± SD	WVTR (g/m ² day ⁻¹) ± SD	AW (%) ± SD	EWC (%) ± SD
SA-G:FCOL:HA 1:1:2 75ng b-FGF	70 ± 10	4254 ± 50	921 ± 44	92 ± 2
SA-G:FCOL:HA 1:1:2-IT:PEDGE 75 ng b-FGF	82 ± 3	4181 ± 206	1190 ± 16	95 ± 1
FCOL:HA 3:5-IT:PEDGE 75 ng b-FGF	87 ± 1	1685 ± 26	1378 ± 99	93 ± 0





- FCOL:HA 3:5-IT:PEGDE-BSA
- SA-G:FCOL:HA 1:1:2-IT:PEGDE BSA
- SA-G:FCOL:HA 1:2:1-IT:PEGDE BSA
- SA-G:FCOL:HA 2:3:3-IT:PEGDE BSA

MTT & Blood Clotting



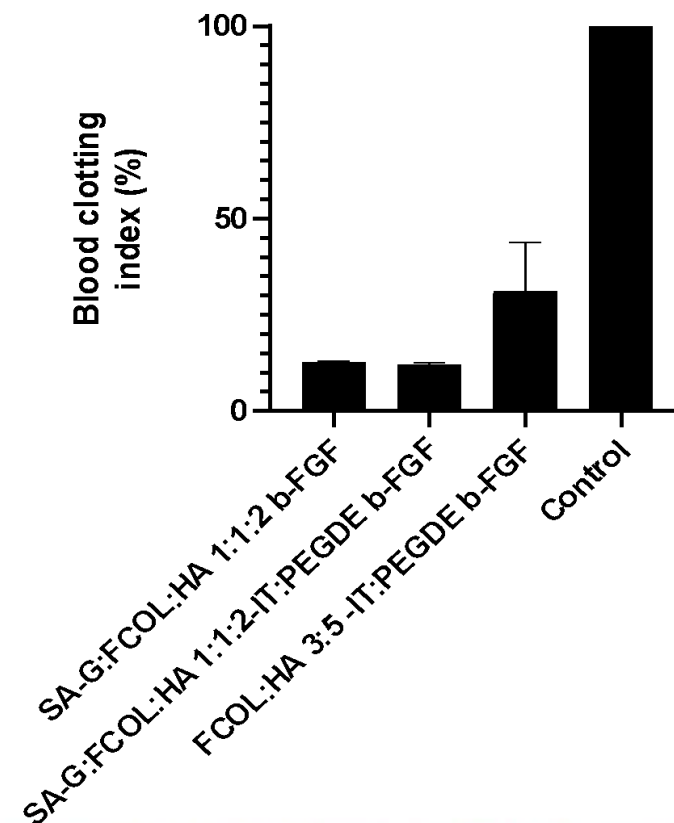
SA-G:FCOL:HA 1:1:2 b-FGF



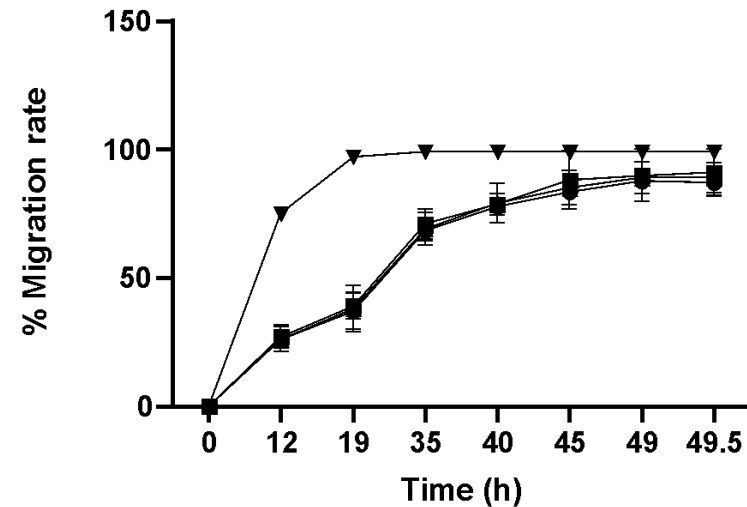
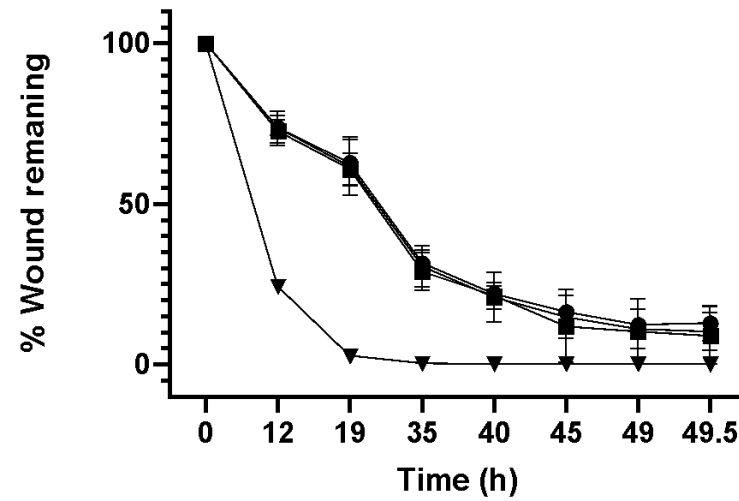
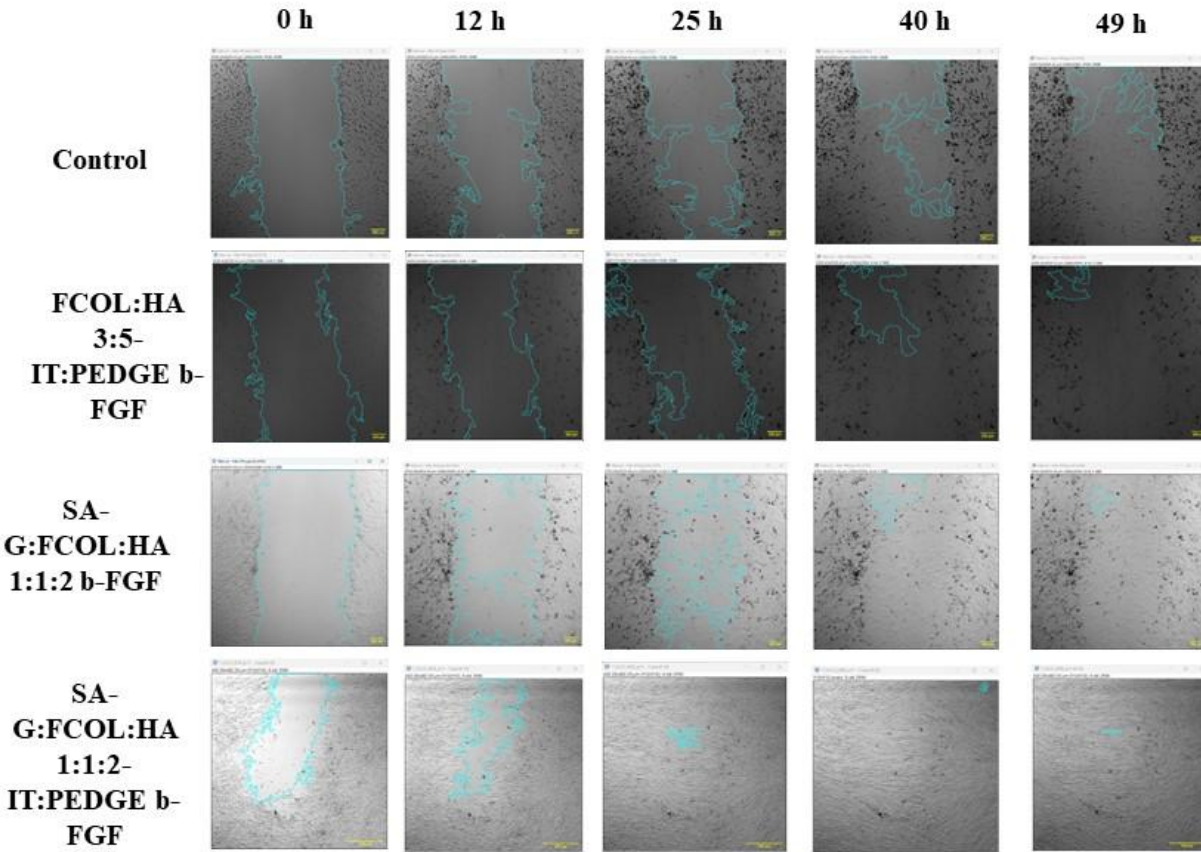
SA-G:FCOL:HA 1:1:2 IT:PEGDE b-FGF



FCOL:HA 3:5 IT:PEGDE b-FGF



Scratch Assay



CONCLUSIONS

PEGDE was able to successfully crosslink HA present in composite SA:FCOL:HA based scaffolds

Superabsorbent, biocompatible and hemostatic properties. Comparable/better than (Promogran™)

Growth factor successfully loaded into the scaffolds

Potential as medicated dressings for delivering proteins to chronic wound sites to take active part in wound healing



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