Ension's Reinforced Collagen Matrix for Wound Healing

Ali Hussain[1], Patrick Cahalan[1], Linda Cahalan[1], Mark Gartner[1], Michelle Evancho-Chapman[2]
[1]Ension, Inc. Pittsburgh, PA 15238, [2]Summa Health Systems, Inc. Akron, OH 44304

Ension, Inc.

TATRC contract

Introduction

During the transportation of wounded warriors, the current management of injuries focuses on resuscitation and stabilization. This wound management paradigm has significantly increased the survivability of our wounded warriors compared to previous conflicts. However, the complex nature and severity of battlefield **burns** and wounds necessitates novel treatment modalities that not only improve survivability but restore functionality to the injured tissues with aesthetically acceptable appearances (i.e. minimal **scarring** and **wound contracture**). In order to regenerate the injured tissue and restore its functionality, the current wound management paradigm must incorporate **regenerative medicine** design features to **prevent wound contraction** early on during the healing cycle and promote functional tissue regeneration.

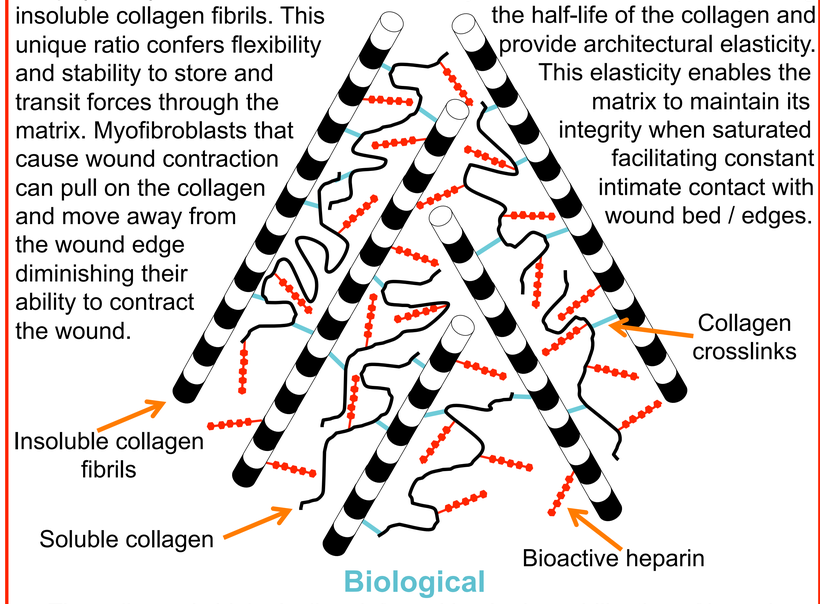
Burn injuries complicate about 5 to 20% of battlefield injuries, usually exhibiting spontaneous epithelialization that results in scarring and wound contracture. The permanent tightening of the skin caused by the contraction replaces the normal elastic skin tissue with inelastic fibrous tissue. **Ension's Reinforced Collagen Matrix (ERCM)** has been developed with regenerative design features specifically to promote regeneration and prevent wound contraction. ERCM's regenerative design features are reinforced in physical, chemical and biological ways:

Physical

Soluble units of triple helical collagen are physically reinforced with natural insoluble collagen fibrils. This unique ratio confers flexibility and stability to store and transit forces through the matrix. Myofibroblasts that cause wound contraction can pull on the collagen and move away from the wound edge diminishing their ability to contract the wound.

Chemical

The collagen is chemically reinforced by covalent crosslinks that prolong the half-life of the collagen and provide architectural elasticity. This elasticity enables the matrix to maintain its integrity when saturated facilitating constant intimate contact with wound bed / edges.



Biological

The collagen is biologically reinforced by the immobilization of heparin within the matrix. Heparin acts as a sequestration and stabilization vehicle for growth factors to increase their surface concentration, promoting cellular proliferation and migration.

The ability of ERCM to prevent wound contraction and promote wound regeneration was evaluated in full thickness wounds in a 28 day swine model. Commercial collagen matrices clinically used for treating full thickness burns and wounds served as control test articles.

Objective

- To evaluate ERCM's ability to **prevent wound contraction** and **promote healing** in a full thickness wound swine model.

Methods

- The swine was anesthetized, intubated and mechanically ventilated with 100% O2 and 1-2% isoflurane. The entire dorsal region was clipped, shaved and prepared for aseptic surgery by cleaning the surface with Hibiclens and alcohol.
- 24 full thickness wounds were introduced in the dorsal region with a #15 scalpel blade using a 2.0 cm square template.
- The skin plug was removed from each wound and the collagen matrices were placed into the wound according to a pre-determined randomization chart. ERCM was compared to commercially available collagen matrices.
- Following hemostasis, each wound was labeled and photographed with a scale marker.
- The swine was observed twice daily to check general health.
- Wound contraction was traced throughout the study period. On Days 21 and 28, wound biopsies were collected for histological evaluations (re-epithelialization, thickness of epithelium, collagen organization, neovascularity, foreign material, foreign body giant cells).
- Collagen matrix integrity at saturation was evaluated in an acute spleen injury model. A 6mm biopsy punch was used to injure the spleen to create actively bleeding wounds. The wounds were covered with the collagen matrices and their physical integrity was monitored.

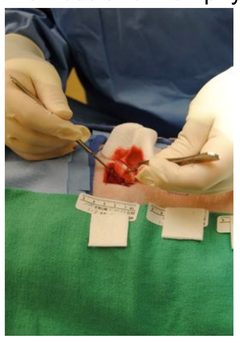


Figure 1. Skin plug being removed from the full thickness wound.

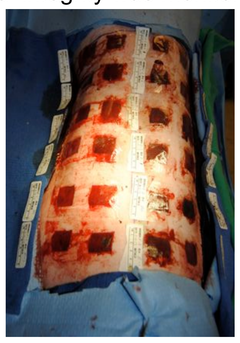


Figure 2. 24 full thickness wounds across the swine's dorsal region.

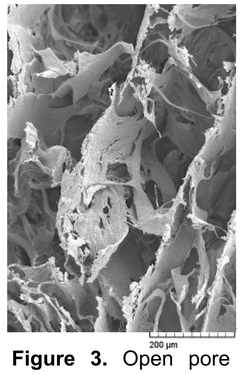


Figure 3. Open pore architecture of ERCM.

Summary and Conclusions

- Burn wounds usually heal with significant wound contracture and scarring.
- Ension's Reinforced Collagen Matrix has been developed with tissue regenerative design features to prevent wound contracture while promoting wound healing.
- ERCM's efficacy and safety was evaluated in a 28 day full thickness wound swine model.
- **ERCM prevented wound contraction** by maintaining 75% of the original wounds' size, while commercial collagen matrices resulted in noticeable and significant contraction; maintaining only 40% of the original wound size.
- Histological analysis demonstrated **ERCM's ability to promote healing while preventing wound contraction**.

Results

Figure 4.
Re-epithelialization of the wound bed was noticed within 10 days post wounding.
Note the visible (white arrow) epithelialization.

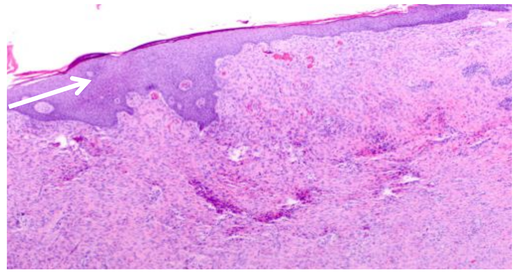


Figure 5.
Collagen organization was observed in the wound biopsies. (left side: is the healing wound that was created, right side: is the uninjured, normal skin tissue)

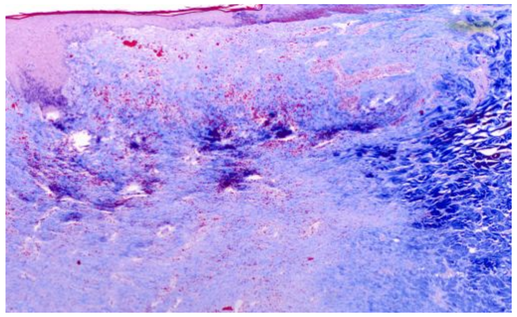
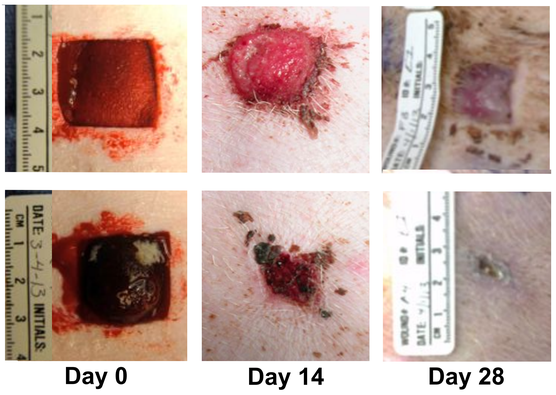


Figure 6. Wound contraction during 28 day swine study

ERCM maintained 75% of its original wound incision width.

Commercial collagen maintained 40% of its original wound incision width.



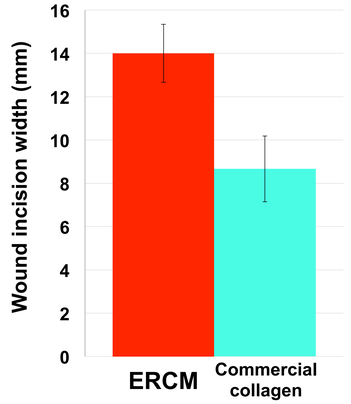


Figure 7. Incision width average of wounds treated with ERCM and commercial collagen. Original width of all 24 wounds on day 0 was 20 mm.

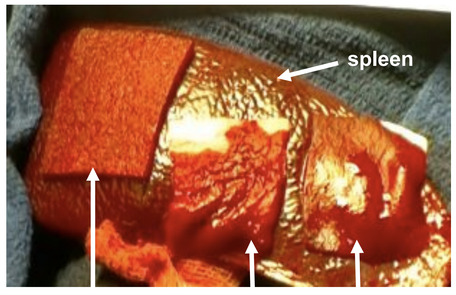


Figure 8. ERCM and commercial collagen covering actively bleeding swine spleen wounds. ERCM maintained its matrix integrity while commercial collagen transformed into a gel. ERCM's stable matrix integrity at saturation allows it to maintain constant intimate contact with the wound bed.