Mechanical Regulation of Burn Wound Scarring through Compression Garment Therapy

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INTRODUCTION
Pressure garments have been utilized for over 50 years to aid in wound healing following severe burn injury over a large portion of the body. These pressure garments constrict the flow of blood, nutrients, and oxygen to the wound, limiting collagen synthesis to prevent scar tissue formation and enhance skin pliability[1]. Current clinical use requires a patient to wear the garment 23 of 24 hours a day for up to 2 years. Compliance rates, with young children specifically, are estimated to be as low as 40%. The purpose of this study was to quantify pressure generated by compression garments on the underlying skin as a function of duration of wear by testing both the material and chemical properties of each of the fabrics used in the manufacture of the garment[2]. An in vivo study on red duroc pigs was also conducted to assess how the garment treatment affects the mechanical properties of the wound scar tissue.

MATERIALS & METHODS


Powernet Fabric: A 9:1 nylon/spandex composite used in the manufacturing of lingerie.

Test Dummy: A human-shaped torso made of a polyurethane compound molded over urethane foam. The exterior has the feel and resiliency of human flesh. Pressure gauges were placed at 5 key locations that have a high radius of curvature.

Tensile Testing: Biopsies from the expired porcine were pulled at a constant strain until broken [Figure 2]. Ultimate tensile strength was determined by the max measured stress.

Garment Energy Dissipation Testing: Garment strips of different orientations were cyclically fatigued and energy loss was calculated from the area change of the hysteresis curve.

Fourier Transform Infrared Spectroscopy (FTIR): When infrared light is passed through a sample, molecular bonds selectively absorb certain wavelengths causing a change in dipole moment. The machine then analyzes the unabsorbed light to determine how much was absorbed by the bonds at each wavelength.

RESULTS: PRESSURE CHANGES ON DUMMY OVER TIME

RESULTS: GARMENT ENERGY DISSIPATION

RESULTS: DUMMY MODEL & CHEMICAL FTIR MAKEUP

RESULTS: SEM STRUCTURAL SURFACE IMAGING

RESULTS: IN VIVO PORCINE MODEL

Red duroc pigs were administered controlled full-thickness burns in 8 locations on their back. Half of their wounds received compression garment therapy treatment while the other were left as controls. The pigs had their bandages changed every 2-3 days and were euthanized after 72 days.

CONCLUSIONS

- Laundering garments 5 times caused no significant chemical or structural alterations to the fabrics, yet effected the pressure loss during static wear suggesting some effect.
- Based on the energy dissipation testing, powernet fabric operates most effectively when stressed along the 0° orientation, while moleskin operates most effectively when stressed along the 45° orientation. Powernet holds constant pressure more effectively than moleskin when on the dummy making it a more suitable material for garment use.
- Compression therapy reduces wound contraction area allowing the scar tissue to have an elasticity much more similar to unburned skin compared to the control burn wounds.
- The collagen fibrils in the treated skin are smaller in diameter and have more consistent shapes which causes the tissue to exhibit higher resiliency when stressed. This produces scar tissue that is more pliable and more durable than the control burn wound tissue.

REFERENCES

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