

A comparative study of the influence of different pressure levels combined with various wound dressings on negative pressure wound therapy (NPWT) driven wound healing

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Introduction

Numerous approaches have been developed to attempt to improve the process of wound healing, including applying negative pressure on the wound surface. With the introduction of new wound dressing technologies, the possibilities of combining negative pressure wound therapy (NPWT) with these new dressings may result in further advancing the quest to find improved wound therapies.

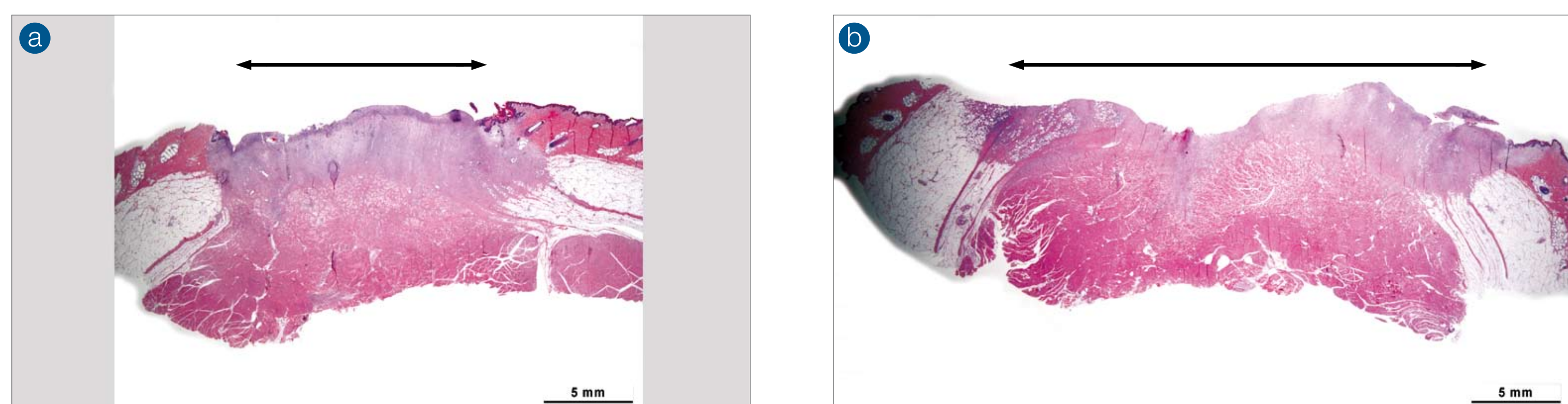
Aim

To carry out a comparison of various existing dressing types in combination with a negative pressure wound therapy system and study the influence on both wound closure and granulation tissue formation in wounds of porcine.

Methods and Results

Five pigs (Landras type) were allowed to acclimatize to the housing conditions prior to all procedures. The animals were sedated, shaved and scrubbed for surgery where full thickness wounds extending to the fascia over the deep back muscles (3.5cm x 3.5cm, maximal 10 per animal) were excised on each pig. Different commercially available materials (foam, gauze, silver, textiles) were used. Each wound site was sealed with a thin air-permeable adhesive film, a flat silicon wound drain was placed on dressing and then connected to a vacuum source which was set to a negative pressure of -10 kPa (-20 kPa and -30 kPa, data not shown). Wound is cleansed with normal saline and dressing is changed every 2nd day. Wound measurements, histology and photographs were collected. Morphological and histological observations indicate that healing is taking place with all dressing types used in combination with NPWT. Giving insights that combining NPWT with different types of dressings provides efficient healing in porcine wound models.

Figure 1: Histology of skin wounds with and without NPWT at 10 days



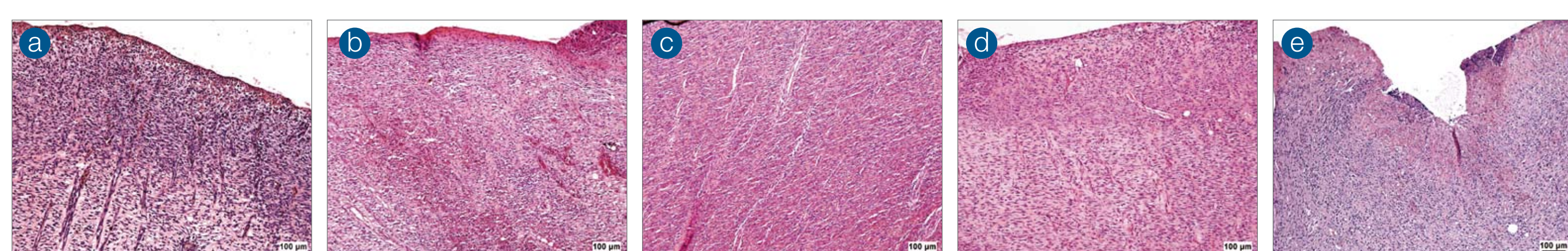
- a) Histology of wound treated with NPWT for 10 days (wound dressed with moist gauze, dressing changed every 2nd day and continuous negative pressure -10kPa (-75mmHg) applied)
- b) Histology of wound treated without NPWT for 10 days (wound dressed with moist gauze, dressing changed every 2nd day). Granulation tissue formation observed in both wounds, however wound treated with NPWT shows a marked wound edge reduction. (A and B) are H&E-stained sections. (Original magnification x 0.5, scale bar = 5mm).

Figure 2: Appearance of skin wounds after treatment with various dressings coupled with NPWT at 4 days



Wounds treated with various commercially available dressings coupled with NPWT, dressings changed 2nd daily with continuous negative pressure -10kPa (-75mmHg). Appearance of wounds at 4 days treated with various dressings (A) ,Gauze**, (B) ,Black Foam***, (C) ,Silver **** and (D) ,Textile***** all coupled with NPWT. (E) Appearance of ,Control' wound without NPWT (wound is cleansed every 2nd day as other treatments, and only a thin air-permeable adhesive film is applied). Most of the wounds appeared pink in color indicative of granulating tissue. However, ,Control' wound appears darker in color in comparison to other wounds.

Figure 3: Histology of skin wounds treated with various dressings coupled with NPWT at 10 days

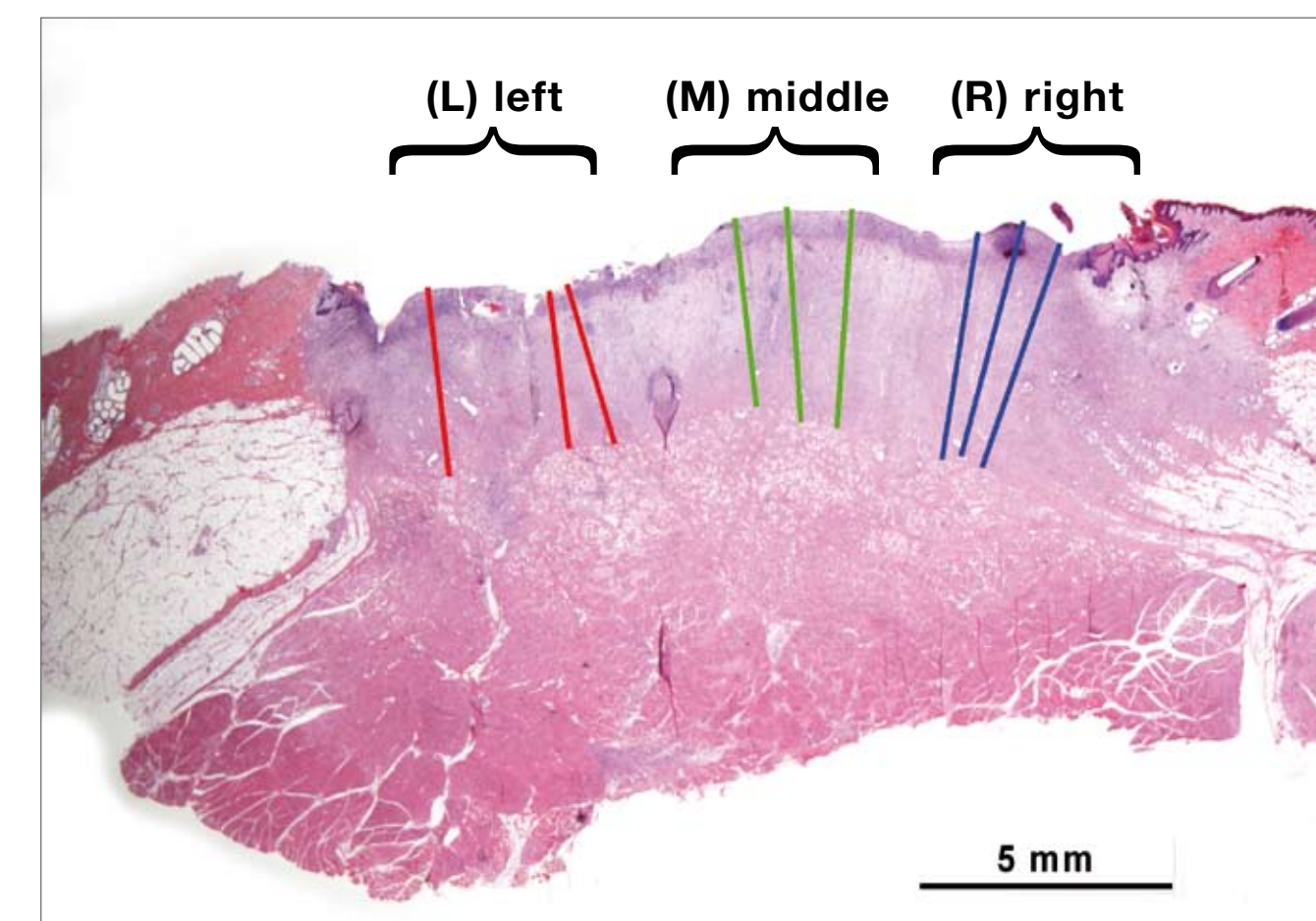


Histology of skin wounds at 10 days and treated with various dressings (A) ,Gauze**, (B) ,Black Foam***, (C) ,Silver **** and (D) ,Textile***** all coupled with NPWT set with negative pressure -10kPa. (E) Appearance of ,Control' wound without NPWT (wound is cleansed every 2nd day as other treatments, and only a thin air-permeable adhesive film is applied). Wounds from all treatments presented with varying degrees of collagen and new small vessel formation. Proliferation of cells in the wound bed was evident in all the treatments (PCNA stains, data not shown). Inflammatory cells were sparsely spread throughout the wound bed from all of the treatments. ,Control' wound appears to have a severe and extensive acute suppurative inflammation dispersed throughout the surface of the granulation tissue. In addition, ,Control' wound presents with moderate focal hemorrhage and a general erythematous appearance on the wound surface. (A to E) are H&E-stained sections. (Original magnification x 10, scale bar = 100 µm).

Notes:

- * Invia® Wound Therapy for NPWT, Medela AG, Baar, Switzerland
- ** V.A.C.® Therapy Systems, KCI, Texas, U.S.A.
- *** Actisorb® Silver 220, Johnson & Johnson Medical Ltd, Skipton, U.K.
- **** 3 mesh®, Müller Textil GmbH, Germany

Figure 4: Granulation tissue formation measurement



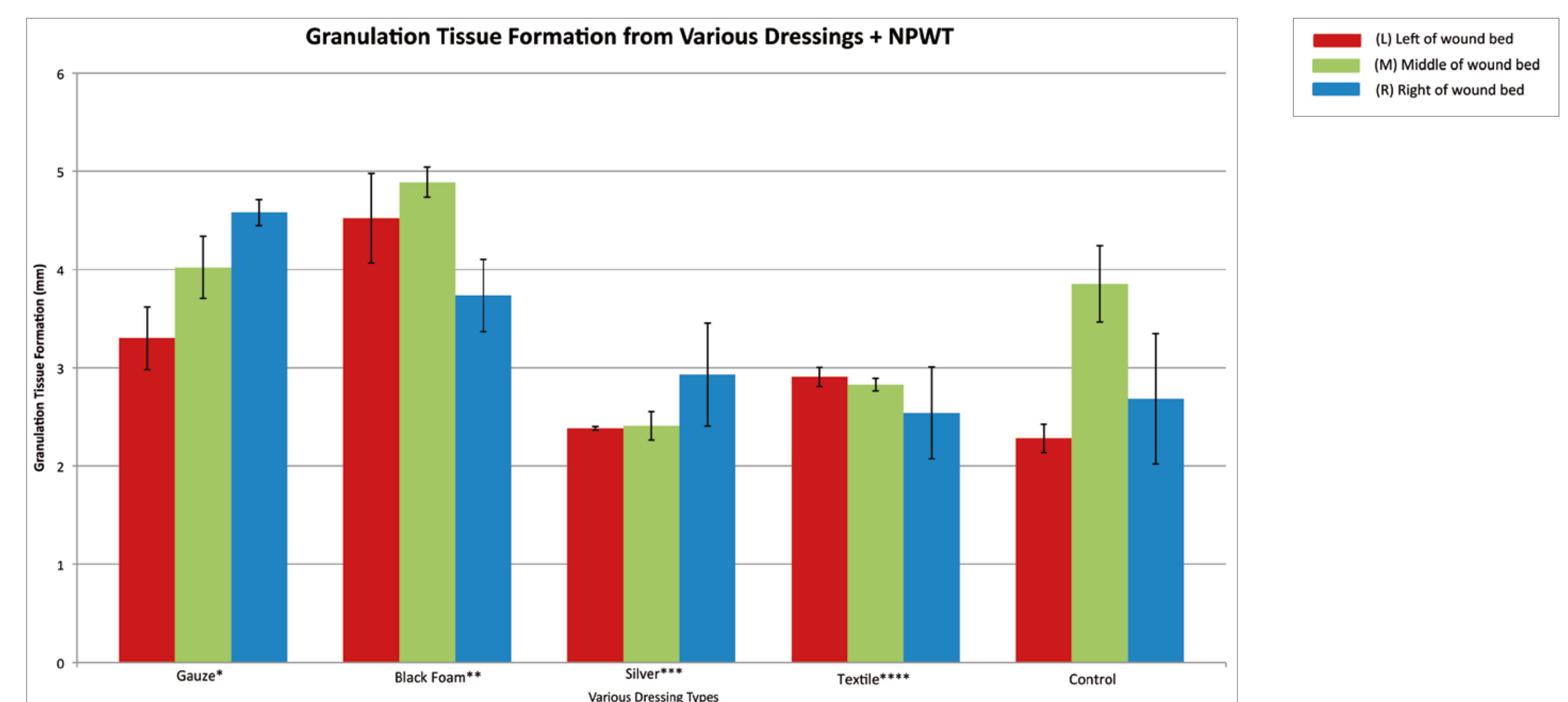
Granulation tissue formation is measured by an imaging program (Leica Microsystems, Leica IM 1000 Professional image management system, Heerbrugg, Switzerland). Three separate areas on the wound bed were measured (3 or more measurements taken per distinct area). Granulation tissue was measured starting from the edge of the wound bed descending down to lower dermis where the proliferation of cells ends. Areas are labeled accordingly, (L) left side of the wound bed; (M) middle of the wound bed; (R) right side of the wound bed. H&E-stained section (Original magnification x 0.5, scale bar = 5mm).

Figure 5: Comparison of measured granulation tissue formation from various dressing treatments coupled with NPWT



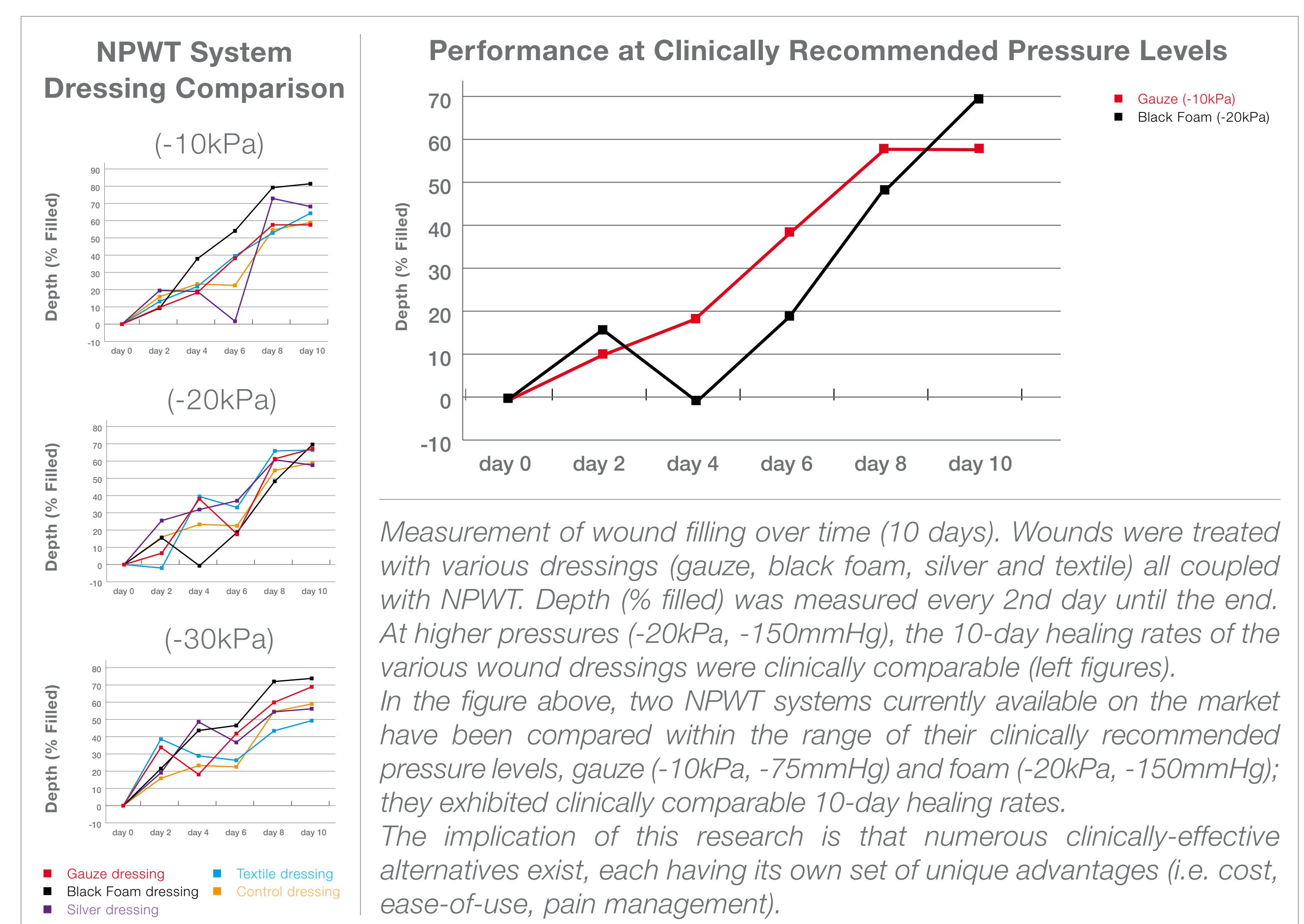
Measurement of skin wounds at 10 days treated with various dressings (A) ,Gauze**, (B) ,Black Foam***, (C) ,Silver **** and (D) ,Textile***** all coupled with NPWT set with negative pressure -10kPa. (E) Measurement of ,Control' wound without NPWT. H&E-stained section (Original magnification x 0.5, scale bar = 5mm).

Figure 6: Extent of granulation tissue formation at day 10



Three to five measurements from the wound bed were averaged for each dressing treatment. Skin wounds are treated with various dressings coupled with NPWT and set with negative pressure -10kPa. The wound bed measurements had distinct locations as described in Figure 4. Error bars indicate S.D.

Figure 7: Comparison of wound measurements from various dressing treatments coupled with NPWT set with different negative pressure levels (-10kPa, -20kPa, -30kPa)



Conclusions

Results suggest that healing is taking place with each one of the dressings used in combination with NPWT on porcine wound model. All new regenerated tissues appeared healthy with collagen and new vessel formation, indicating good response of the wound to the treatment applied. Although healing was observed in the control wound, the morphological and histological analysis clearly shows the tissue to be more unhealthier in appearance when compared to other treatments combined with NPWT.

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