

A comparison of various wound dressings coupled to a negative pressure wound therapy (NPWT) system to study effects on wound healing progression

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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

Landras type pigs were allowed to acclimatize to the housing conditions prior to all procedures. The animals were anesthetized, 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. The wounds were filled with various commercially available dressing types (foam, gauze 1, gauze 2, silver, textiles), and coupled with NPWT for 10 days. Each wound site was sealed with a thin air-permeable adhesive film, a flat wound drain was placed on the dressing and then connected to a vacuum source which was set to negative pressures of -10 kPa (-75 mmHg) (-20 kPa [150 mmHg] and -30 kPa [-225 mmHg], data not shown). The 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 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 wounds with and without NPWT at 10 days

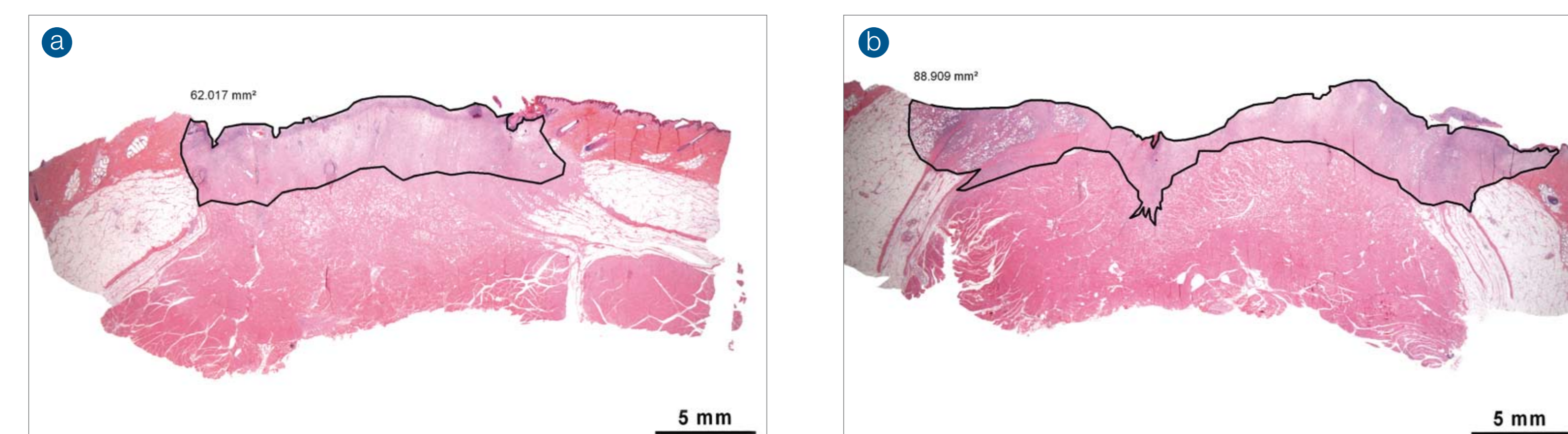


Fig.1A
Histology of wound treated with NPWT for 10 days (wound dressed with moist gauze, dressing changed every 2nd day and continuous negative pressure -10kPa (75mmHg) applied)

Fig.1B
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 and wound area reduction (Fig.1A gauze with NPWT) when compared to wound treated with gauze alone (Fig.1B gauze without NPWT). Figures A and B are H&E-stained sections. (Original magnification x 0.5, scale bar = 5mm).

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
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Figure 2: Histology of wounds treated with various dressings coupled with NPWT at 10 days

Histology of wounds at 10 days and treated with various dressings (A) ,Gauze I** (B) ,Black Foam***, (C) ,Silver **** (D) ,Textile***** and (E) ,Gauze II ***** all coupled with NPWT (-10kPa). (F) 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 F) are H&E-stained sections. (Original magnification x 20, scale bar = 100 µm).

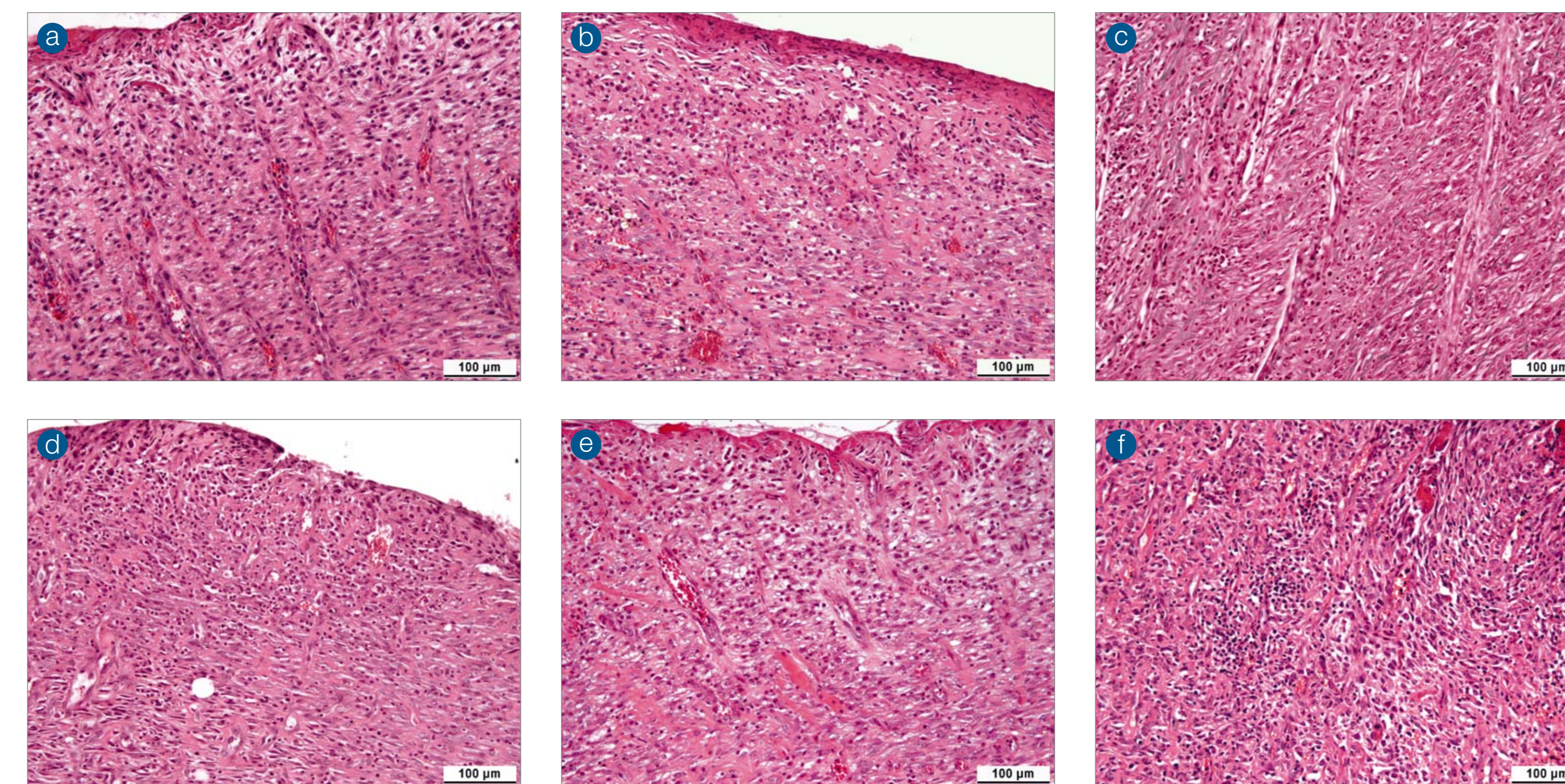
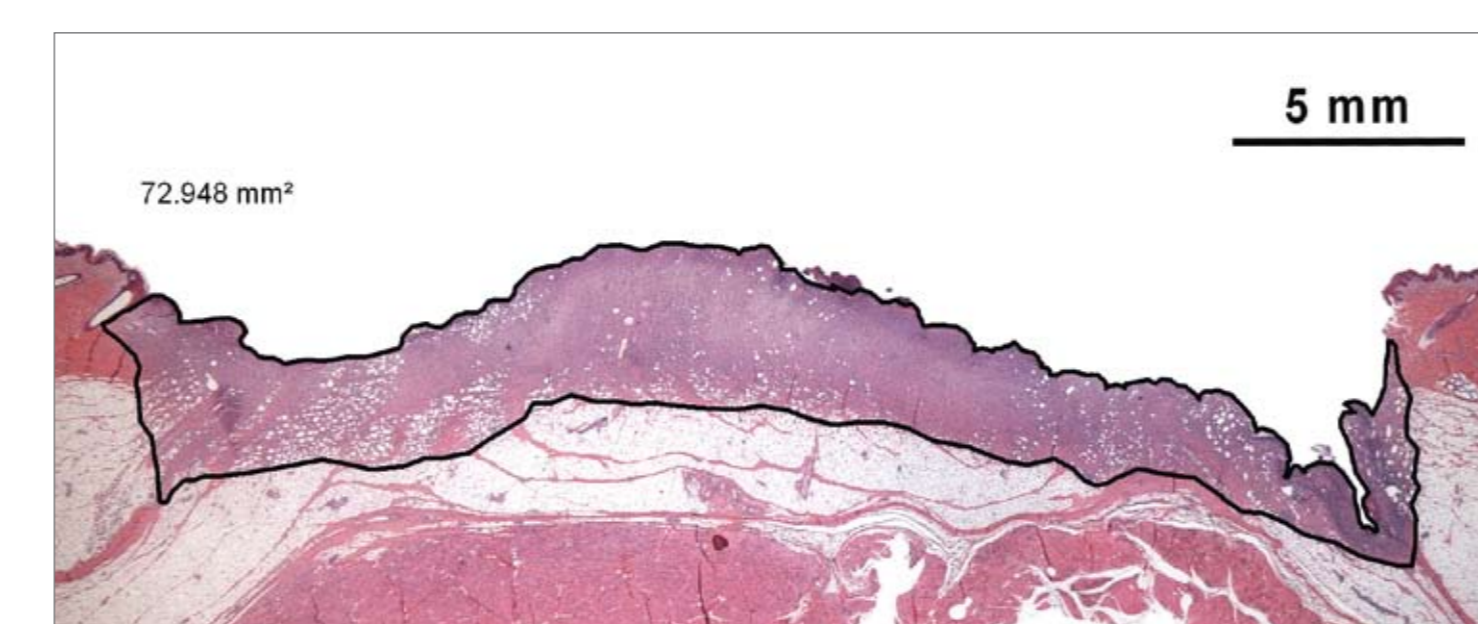


Figure 3: Wound area measurement



The area of wound healing is measured by an imaging program (Leica Microsystems, Leica IM 1000 Professional image management system, Stereo microscope [Leica MZ16] and Camera [Leica DC480], Heerbrugg, Switzerland). The area where tissue granulation is evident was measured accordingly. (Original magnification x 0.5, scale bar = 5mm).

Figure 4: Comparison of wound area from various dressing treatments coupled with NPWT

Photographs of wound area at 10 days treated with various dressings (A) ,Gauze I** (B) ,Black Foam***, (C) ,Silver **** (D) ,Textile***** and (E) ,Gauze II***** all coupled with NPWT set with negative pressure -10 kPa (-75 mmHg). (F) Measurement of ,Control' wound without NPWT. H&E-stained section (Original magnification x 0.5, scale bar = 5mm).

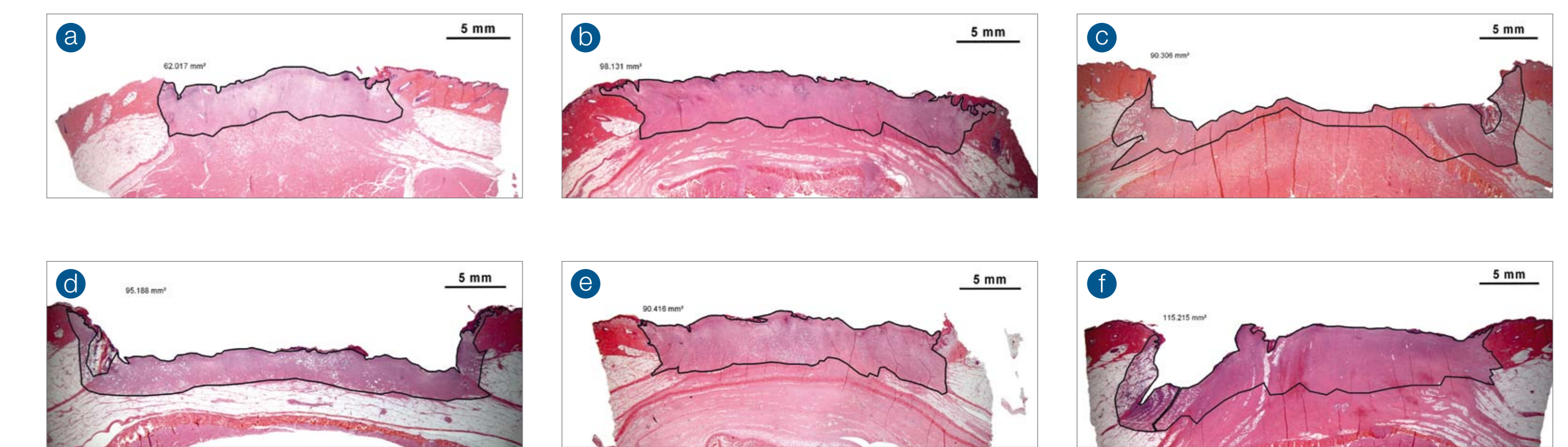


Figure 5: Extent of wound area reduction at day 10 from various dressing treatments coupled with NPWT

Measurement of wound area at 10 days treated with various dressings ,Gauze I** ,Black Foam***, Silver **** ,Textile***** and ,Gauze II***** all coupled with NPWT set with negative pressure -10 kPa (-75 mmHg). Measurement of ,Control' wound without NPWT.

Wound Area Measurement from Various Dressings + NPWT

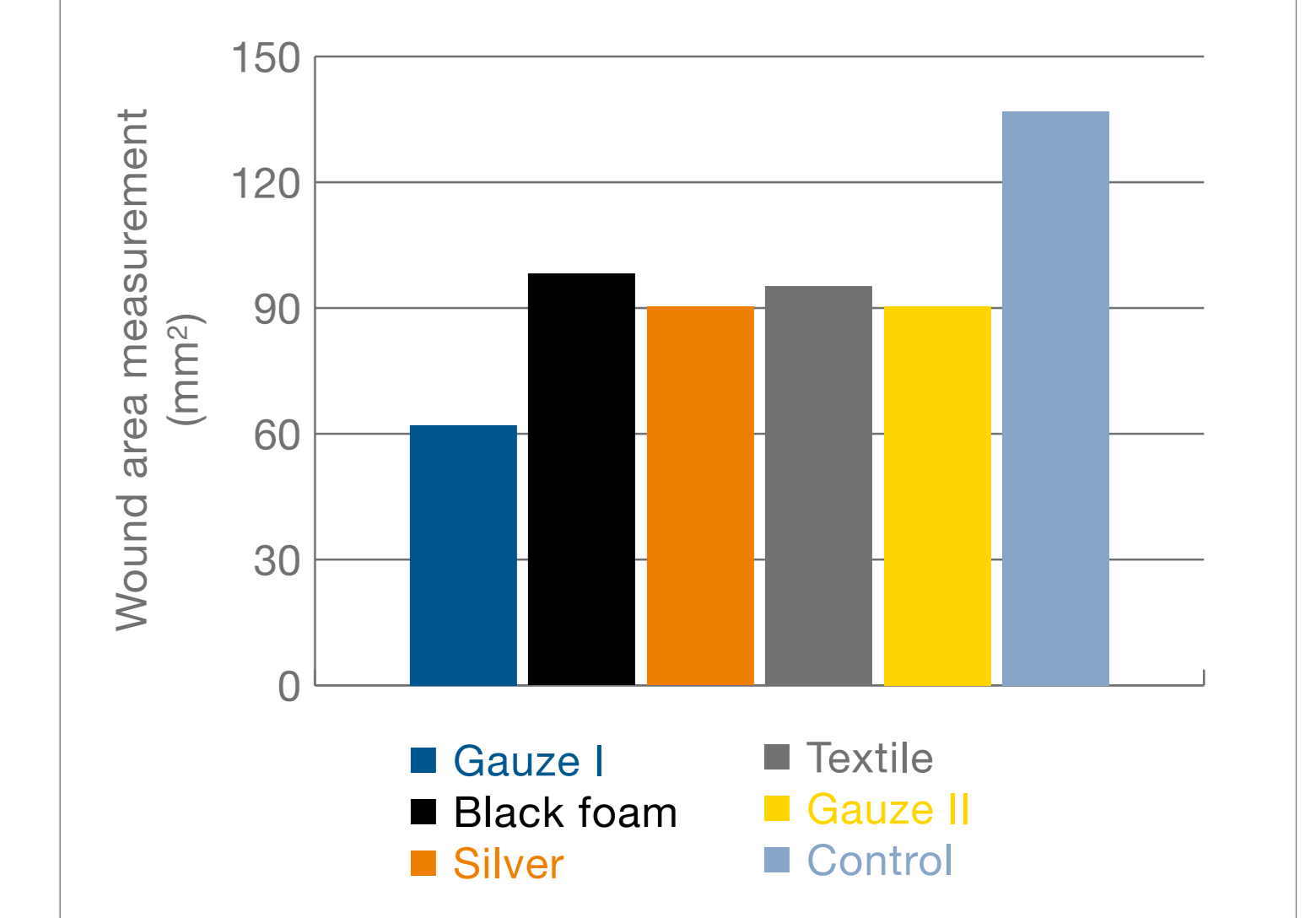
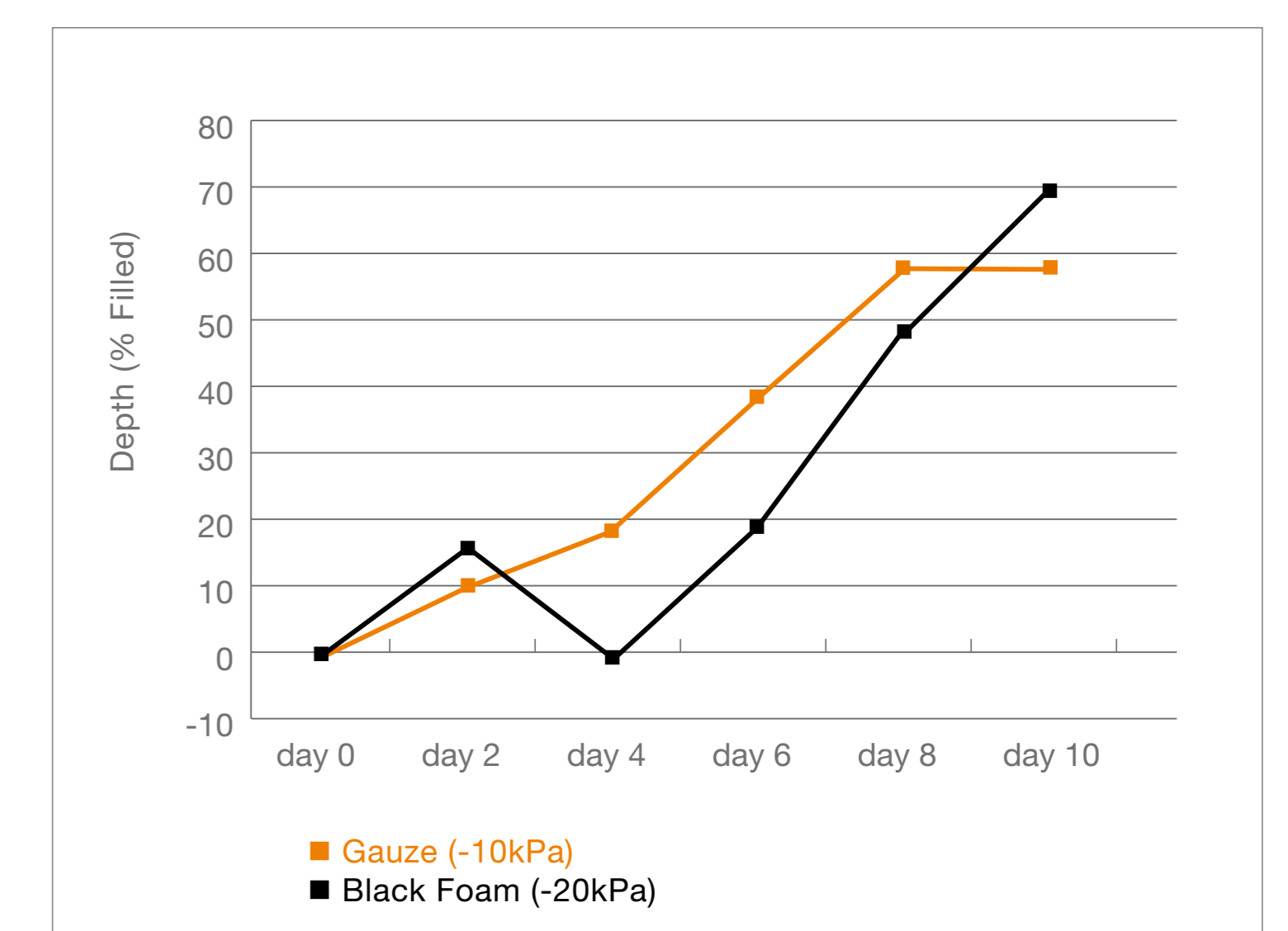


Figure 6: Performance at Clinically Recommended Pressure Levels

Measurement of wound filling over time (10 days). Wounds were treated with ,Gauze I** or ,Black Foam*** all coupled with NPWT. Depth (% filled) was measured every 2nd day until experiment end. In the figure on the right, two NPWT systems currently available on the market have been compared within the range of their clinically recommended pressure levels, gauze (-10kPa, -75mmHg) and foam (-20kPa, -150mmHg); they exhibited clinically comparable 10-day healing rates. The implication of this research is that numerous clinically-effective alternatives exist, each having its own set of unique advantages (i.e. cost, ease-of-use, pain management).

Performance at Clinically Recommended Pressure Levels



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 is unhealthier in appearance when compared to other treatments combined with NPWT.