

Understanding the Biomechanical Effects of a Novel tNPWT+DL⁺ Dressing

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Introduction

- Whilst traditional Negative Pressure Wound Therapy (tNPWT) systems have demonstrated efficacy in managing hard-to-heal wounds¹, they are limited by their localized pressure delivery. In contrast, single-use NPWT (sNPWT) systems² have shown accelerated healing outcomes, attributed to their ability to distribute negative pressure across a wider therapeutic zone. To bridge this gap, a novel cuttable and repositionable tNPWT dressing, enhanced with a distribution layer (tNPWT+DL⁺) has been developed (Figure 1).

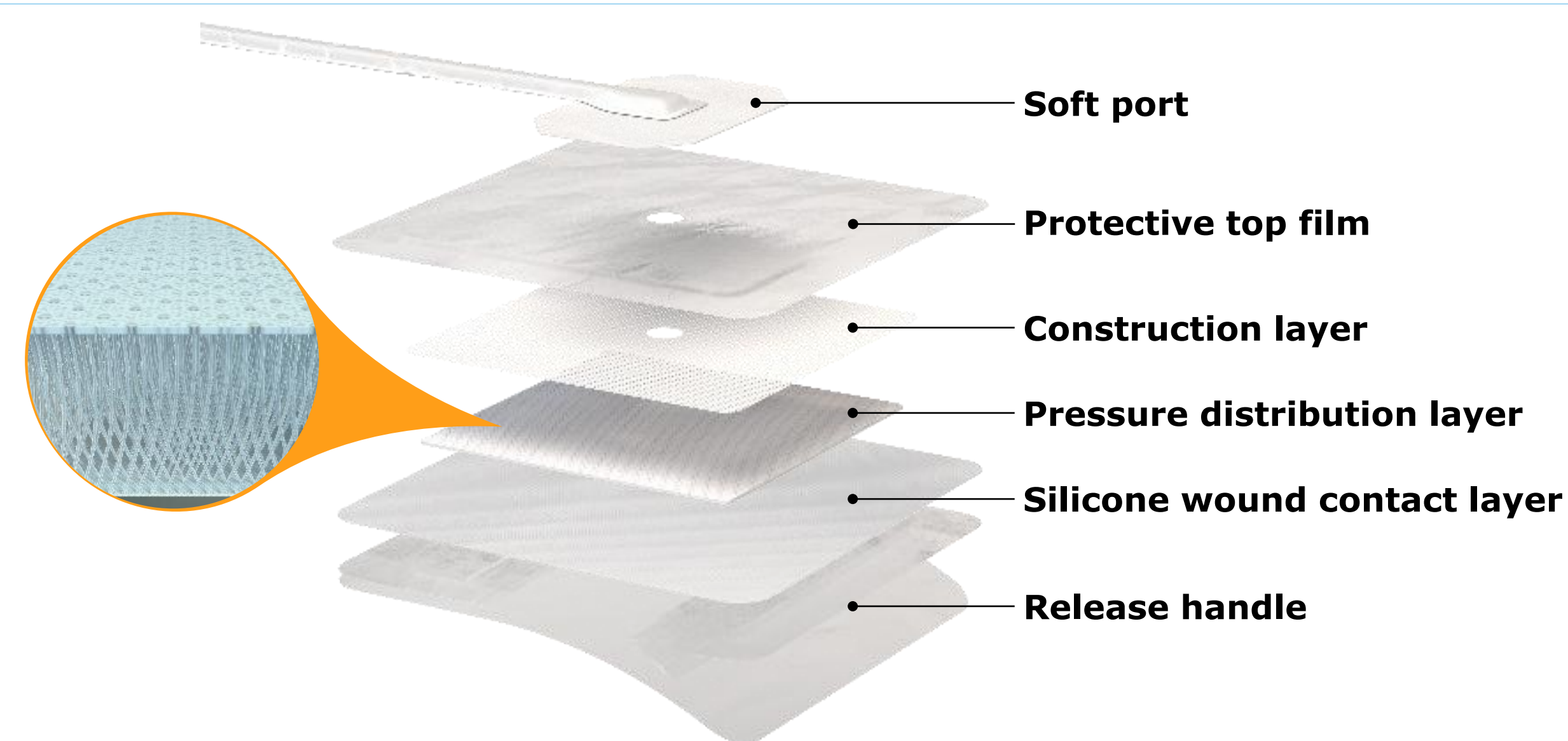


Figure 1. Novel tNPWT+DL⁺ dressing and constituent layers.

Study Aim

- To map the biomechanical responses of tissue when undergoing therapy delivered by the tNPWT+DL⁺ dressing compared to those generated by tNPWT with drape and foam filler*.

Methodology

- In vitro* studies conducted with porcine tissue substrates (pork belly tissue with a minimum depth of 30 mm, n=3).
- Wounds (~ 30 mm diameter, ~15 mm deep) were created followed by the application of NPWT systems with a foam filler using a 15 cm × 15 cm dressing (10 cm × 10 cm pad size).
- Tissue pressure experienced under dressings were obtained through calibrated needle probes inserted into the tissue at various depths and locations over a 12 h period.
- Tissue displacement (up to 24 h) was demonstrated by inserting metallic markers into the porcine tissue in a grid pattern and imaging with micro-CT with and without the application of the NPWT. The data was then used to validate a finite element analysis (FEA) model.

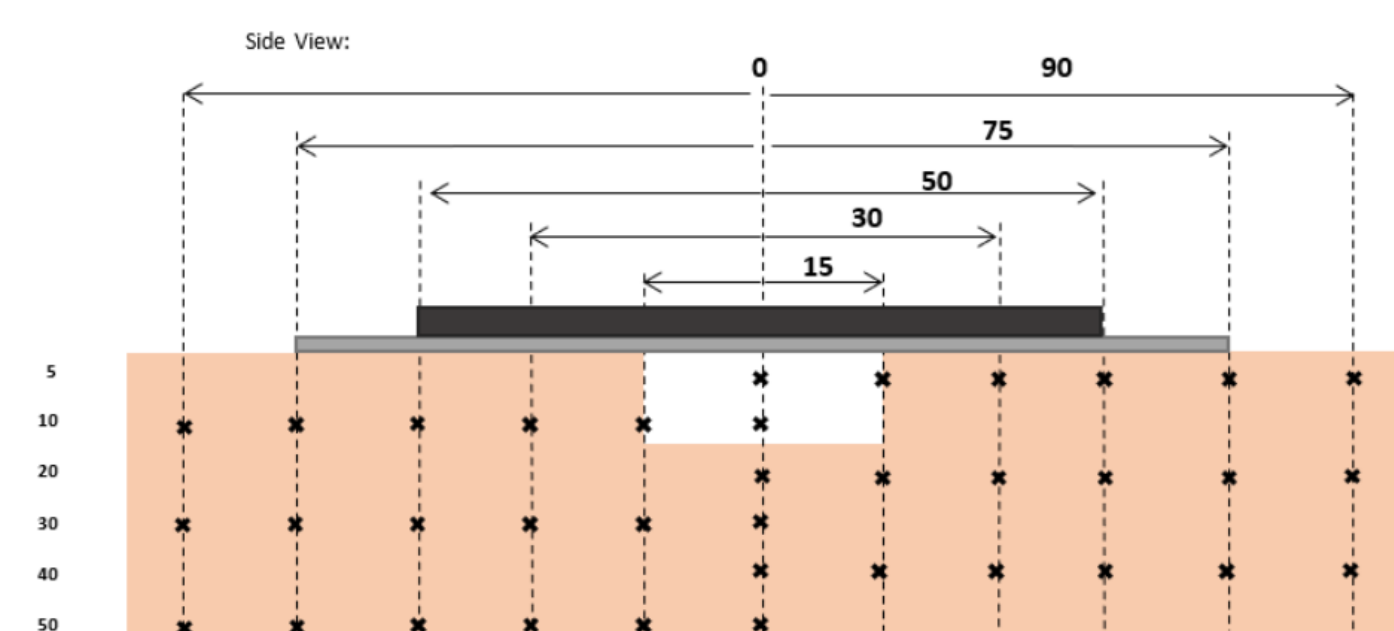


Figure 2. Representation of moisture measurement sensor locations (in mm) on wounded porcine tissue model.

Methodology cont.

- Tissue moisture movements were detected using bespoke sensors placed at various depths and locations surrounding the wound as indicated in Figure 2.
- Moisture sensor data was collected over a range of time points over 4 h with the probe left in place for 30 s for each reading, and the mean resistance (MΩ) was calculated for each time stamp. Colour maps of % change in moisture as a function of time were then produced in MATLAB™ (The MathWorks, Inc.).

Results

- The tNPWT+DL⁺ dressing delivers significantly greater NPWT in the tissue that spans beyond the wound area, and to wider regions when compared to tNPWT* (p<0.05), with a -47.38 mmHg (6.86-fold) increase in delivery of NPWT at pad edge (Figure 3).

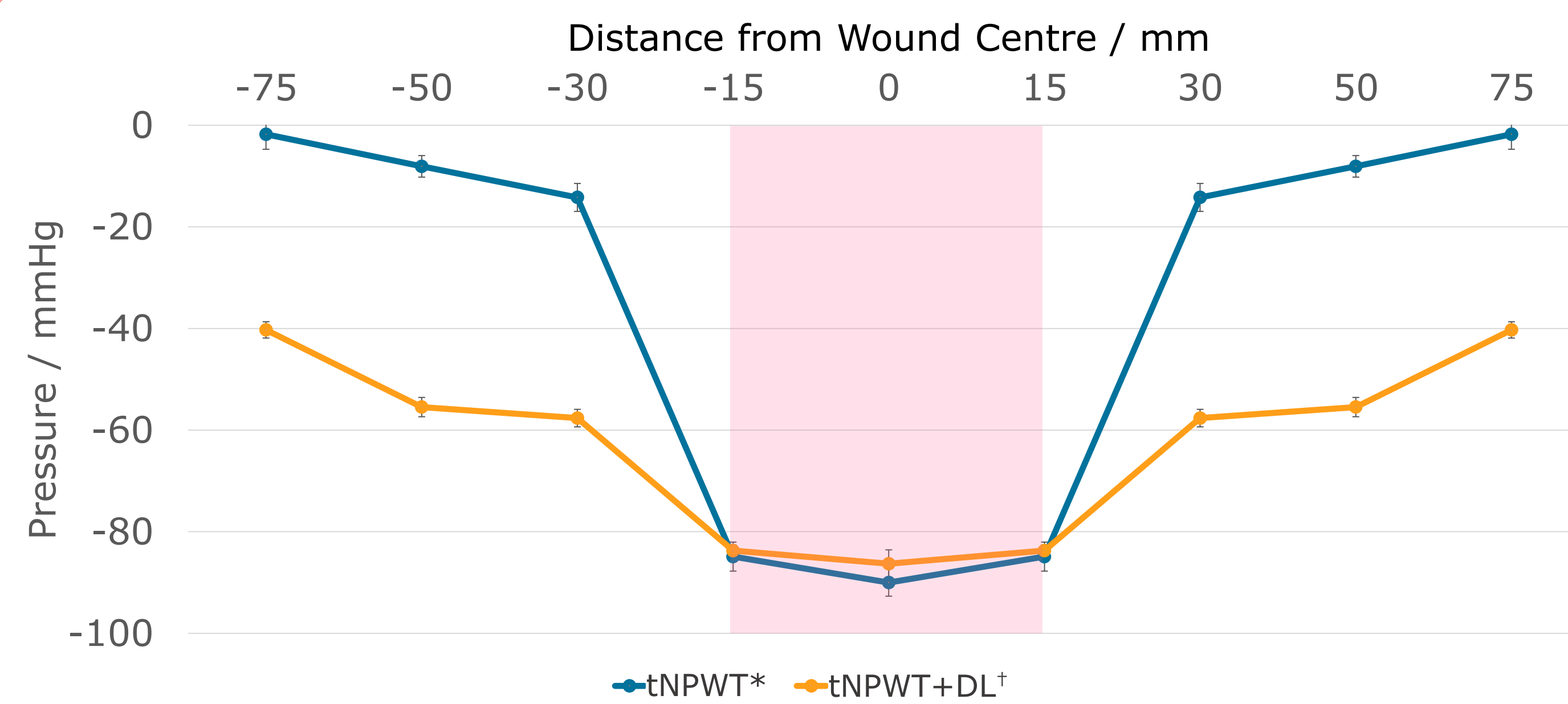


Figure 3. Mean (n=3) measured pressure (mmHg) with respect to distance from WC (0 mm) for each mode of therapy at a depth of 30 mm, 12 h of therapy. The pink zone represents the area under the wound.

- The tNPWT+DL⁺ dressing delivers significantly greater tissue displacement, and therefore compressive forces, that extend beyond the wound area and to wider regions when compared to tNPWT* (p<0.05), a 12.35-fold increase at pad edge (Figure 4). This can also be demonstrated via FEA analysis (Figure 5).

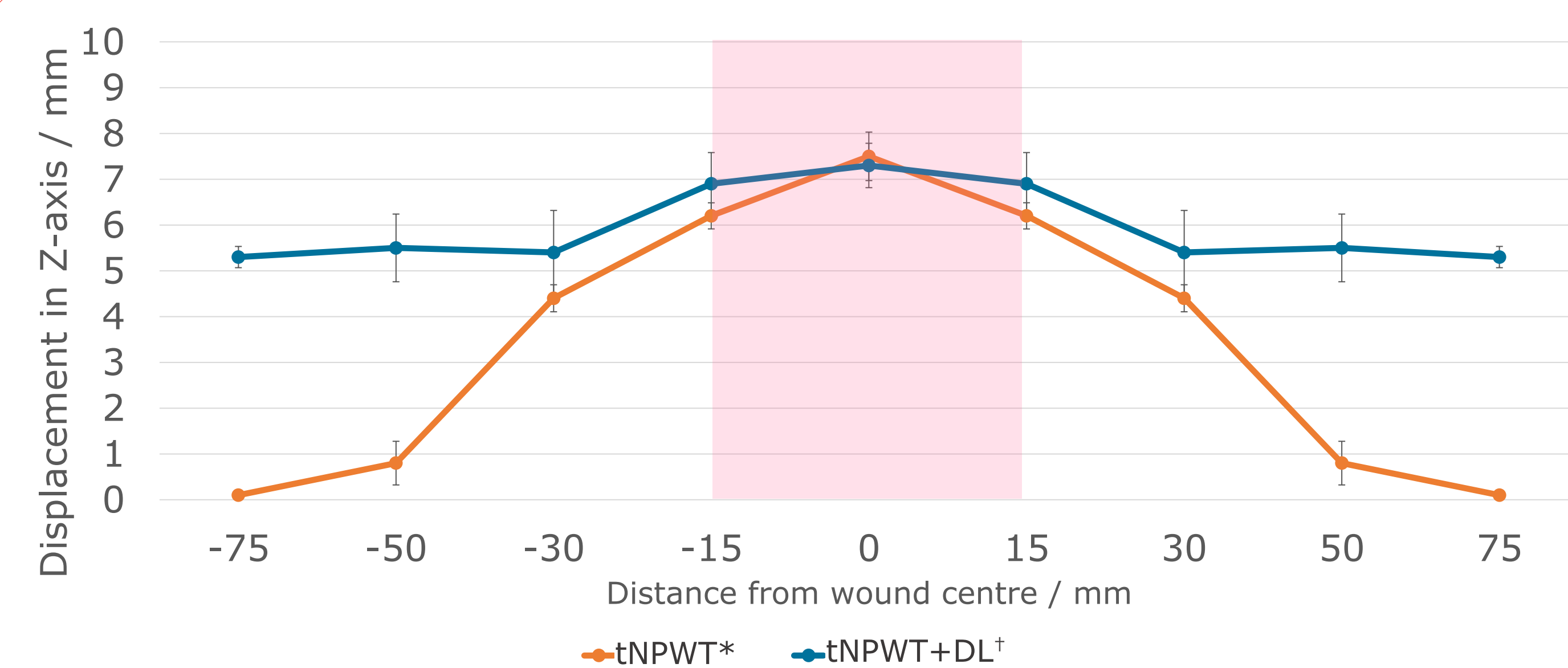


Figure 4. Mean (n=3) tissue displacement (mm) with respect to distance from WC (0 mm) for each mode of NPWT. at various depth of 30 mm at 12 h. The pink zone represents the area under the wound.

Results cont.

- The tNPWT+DL⁺ dressing demonstrated greater moisture movement into regions beyond the wound, whereas tNPWT* demonstrated a more localised effect (Figure 6).

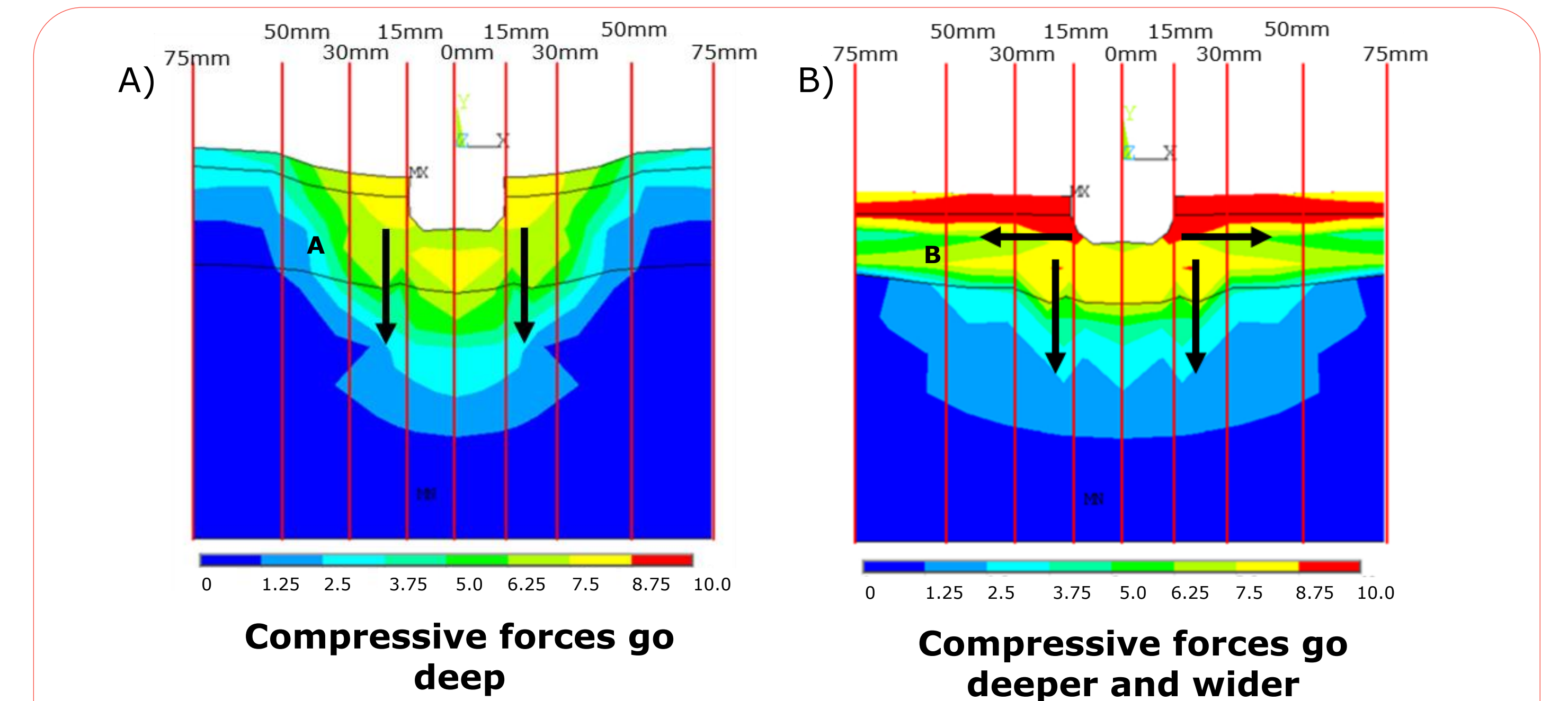


Figure 5. 2D wound finite element analysis model (ANSYS™) showing tissue displacement values (mm), validated with *in vitro* measurements using metallic markers and CT scanning to calculate displacement across the porcine tissue with A) tNPWT*, or B) tNPWT+DL⁺.

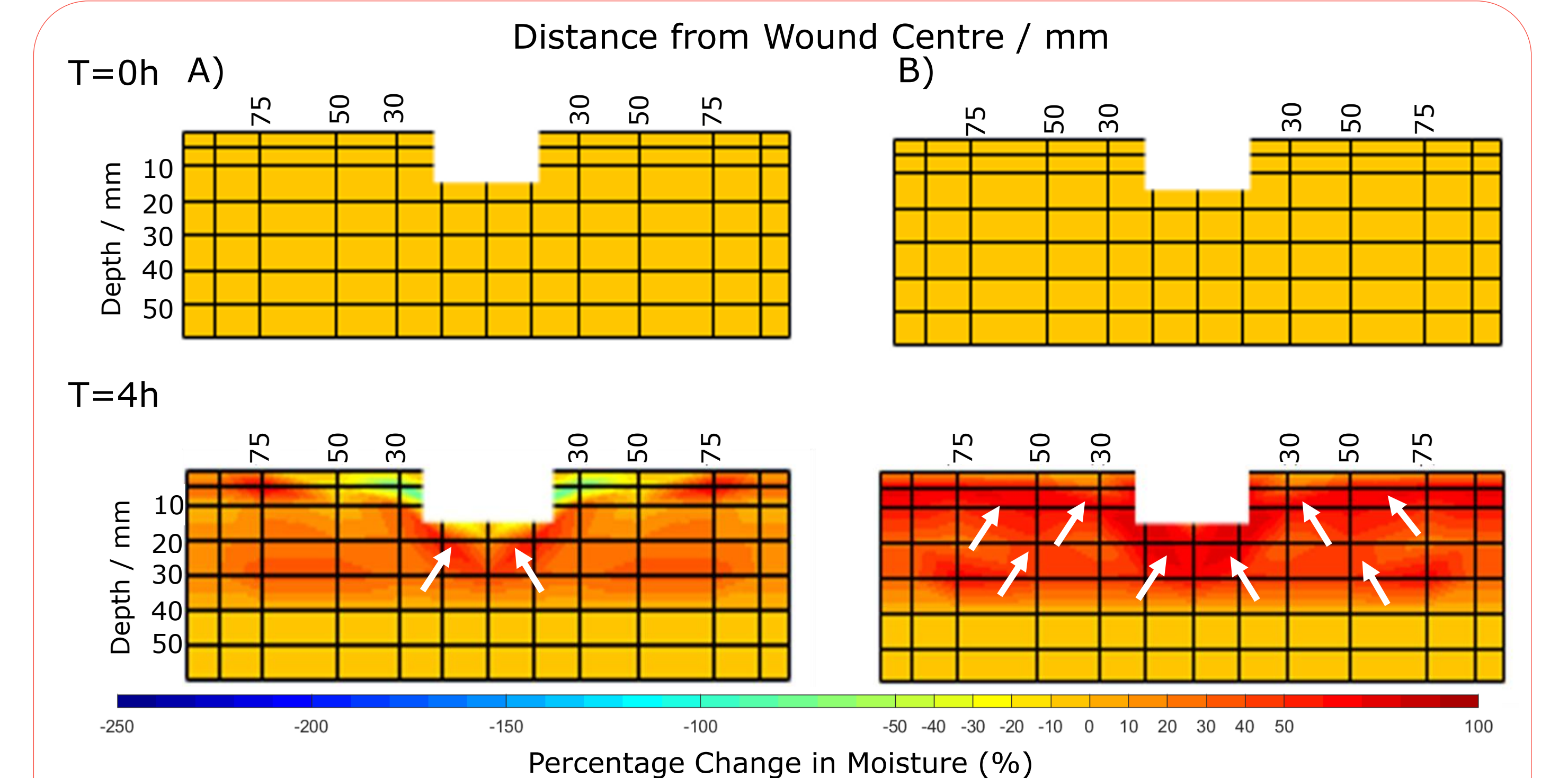


Figure 6. Moisture movement (% change) in porcine tissue model for a) tNPWT*, b) tNPWT+DL⁺. Data represented as averaged (n=3) colour maps at 0 h and 4 h. Red denotes positive change in moisture movement, white arrows indicative of moisture movement.

Conclusions

- The tNPWT+DL⁺ dressing delivers more uniform negative pressure that goes beyond the wound.
- The tNPWT+DL⁺ dressing delivers compressive forces and moisture movement that goes beyond the wound.
- These effects may help manage oedema and excessive interstitial fluid³ surrounding the wound to support a pro-healing environment.
- These findings support that the novel tNPWT+DL⁺ dressing successfully delivered the benefits of NPWT to wider tissue regions, creating a wider zone of therapy. This is consistent with previous findings on the use of sNPWT systems².

References: 1. Hurd T, et al. Adv Wound Care (New Rochelle). 2017 Jan 1;6(1):33-37. 2. Kirsner R, et al. Wound Repair Regen. 2019 Sep;27(5):519-529. 3. Birke-Sorensen H, et al. Journal of Plastic, Reconstructive & Aesthetic Surgery. 2011;64:S1-S16.