Introduction: The use of negative pressure wound therapy with open cell foam has become ubiquitous in orthopaedic surgery as well as other fields, particularly when wound care and closure are difficult. Negative pressure wound therapy is a relatively new treatment for wound healing and thus, the mechanisms of action and clinical indications are not fully explored. The increasing use of this technique has raised awareness of potential complications, for example vessel rupture at the site of negative pressure wound therapy has been reported anecdotally [1,2]. Current guidelines for negative pressure wound therapy, mostly based on anecdotal evidence, warn against applying negative pressure to visible vessels, tendons, nerves or sensitive organs within the wound. While there are questions regarding potential interstitial pressure mediated effects on deep tissue structures no data exist regarding the transmission of negative pressure through tissue. Therefore, this study examined the depth to which negative pressure wound therapy affects interstitial fluid pressure within wound tissue. We attempted to expand upon the preliminary study conducted by Kilpadi and coworkers that also had limited depth resolution due to hydrostatic effect and the use of a lower resolution micromanipulator [3]. We hypothesized that interstitial fluid pressures are not affected by the application of negative pressure deeper than 2mm into wound tissue.

Materials and Methods: Following Institutional Animal Care and Use Committee approval, ten New Zealand White rabbits between 2-3kg were used for this study. They were sedated and had their dorsum and hindquarters shaved. The rabbits were then placed on a water-heatling pad, intubated, placed on a ventilator, and anesthetized. A 2cm x 2cm square was marked to identify the site for wound creation. The shaved areas were then treated with depilatory cream. The skin was then incised with a scalpel and removed along with the subcutaneous adipose and fascial layers. The fascial covering of the underlying gluteus muscle was incised with a scalpel, separated from the muscle tissue, and removed. A 2cm x 2cm piece of VAC GranuFoam® Thin dressing (open cell reticulated) (KCI, San Antonio, TX, USA) was placed over the wound and adhesive drape was used to isolate the wound. The dressing was then attached to a V.A.C.® Freedom System (KCI) for application of negative pressure to the wound. Pressure settings of 0, -75, -125, -200mmHg were applied in randomized order. Interstitial fluid pressure measurements were continuously measured using a 1.4 French (0.46mm diameter) MikroTip Pressure Transducer Catheter (Millar Instruments, Houston, TX, USA), as previously described [4]. Prior to each animal study the pressure transducer was calibrated. The pressure transducer was introduced to the wound tissue through the dressing via an 18g needle inserted perpendicular to the wound surface with a micromanipulator to a depth of 10mm. The transducer was then retracted in 0.1mm increments, measuring pressure at each 0.1 mm depth. Data were analyzed using a 2-way repeated measures ANOVA to evaluate effects of negative pressure setting and depth. Post hoc analyses were performed using paired student t-tests to determine significant differences in interstitial fluid pressure between the various negative pressure settings to control setting measurements at each 0.1mm depth. Significance was set at p<0.05.

Results: The effects of tissue depth, pressure applied, as well as the interaction between depths and pressure settings were all significant (Fig. 1). Interstitial fluid pressure corresponded inversely with depth (p<0.001) and directly with negative pressure levels (p<0.001). Interstitial fluid pressures were significantly less when the negative pressure was set to -200mmHg than the 0mmHg control at depths of 0.0mm to 0.9mm. At a setting of -200mmHg, interstitial fluid pressures at 1.0mm to 10mm were similar to control pressures at corresponding depths. Interstitial fluid pressures were significantly less when the negative pressure was set at -125mmHg than control pressures at depths of 0.0mm to 0.4mm. At a setting of -125mmHg, interstitial fluid pressures at 0.5mm to 10mm were similar to control pressures at corresponding depths. Interstitial fluid pressures were significantly less when the negative pressure was set to -75mmHg than the control at depth measurements of 0.0mm to 0.5mm. At -75 mmHg, interstitial fluid pressures at 0.6mm to 10mm were similar to control pressures at corresponding depths.

Discussion: The effect of negative pressure wound therapy on interstitial fluid pressure is dissipated rapidly, becoming equal to control values within the first millimeter of wound tissue below the foam dressing. This result suggests that tissues beneath 1mm are not exposed to pressures that are statistically more negative than normal interstitial fluid pressure. Therefore, tissues beneath 1mm are probably not affected by changes in interstitial pressure, induced by application of negative pressure wound therapy. Thus tissues deep to the application surface appear to be isolated from the effects of negative pressure induced changes in interstitial fluid pressure. In conclusion, the effect of negative pressure wound therapy on interstitial fluid pressures does not extend significantly beyond 1mm of tissue depth from the wound surface. Thus, it is probable that effects and complications related to interstitial fluid pressure do not extend beyond this depth.


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