A NOVEL BIO-INSPIRED SKIN GRAFT ADHESIVE

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INTRODUCTION

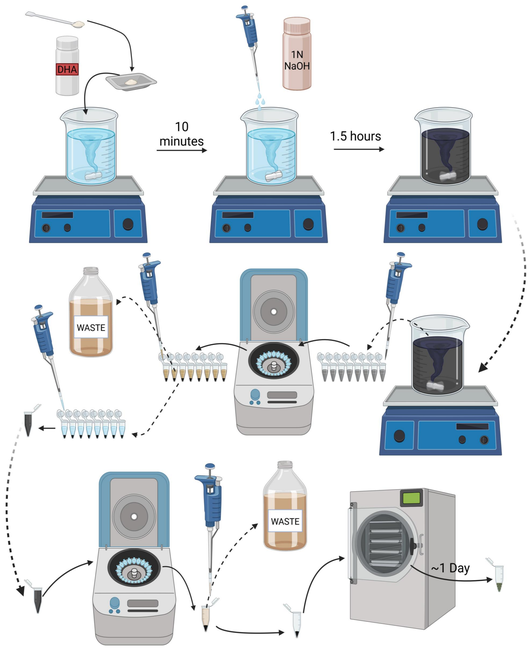
Early grafting following burn injury has been shown to improve clinical outcomes. To facilitate engraftment, effective fixation of the graft is paramount as even minimal shear forces may result in avulsions and blistering, delayed healing and impaired anastomosis of the autograft. Current methods of fixation include sutures, vacuum system, staples, and fibrin glue. Each of these methods have drawbacks which include extended application times, reliability concerns, and systemic inflammatory response. A low-cost, reliable method to promote graft adhesion without increasing inflammation would be beneficial. Polydopamine is a diverse molecule that is used in many applications to adhere drugs, ions, or polymers to itself or other surfaces. Polydopamines adhesive properties result from its amine and catechol groups which allow it to participate in hydrogen bonding, covalent bonding, and electrostatic interactions. Our novel PDA/BSA adhesive particles take advantage of these properties to form an efficient, non-toxic, and effective adhesive.

GOAL

Develop a novel, bio-inspired adhesive that adequately adheres split thickness skin grafts (STSG) to a wound bed (WB) and promotes angiogenesis of the graft, inherently improving graft take while reducing recovery time.

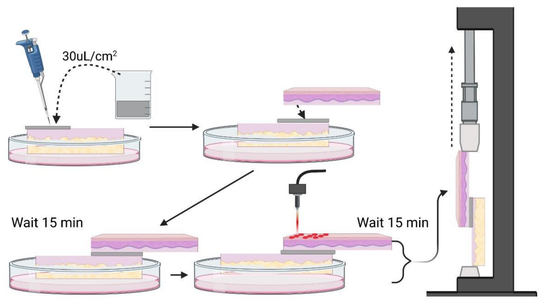
MATERIALS & METHODS

PDA Particle Formulation



In Vitro Testing

1. Characterize PDA particles via TEM, SEM, size analysis
2. *In vitro* cytotoxicity assays
   - *f* (Conc. of PDA)
   - *f* (NIR exposure)
3. Strength of adhesion
   - *f* (PDA concentration)
   - *f* (NIR laser pattern)



RESULTS & DISCUSSION

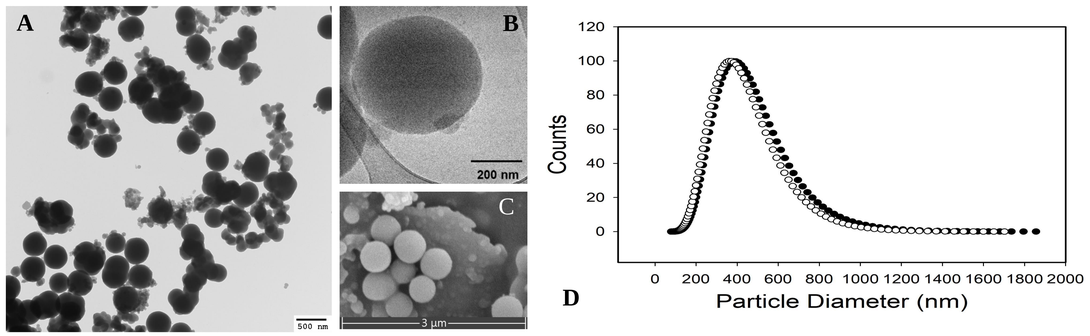


Figure 1. TEM image of PDA particles A) showing the relative size distribution and B) higher magnification view of the average size PDA particle. C)SEM analysis shows the surface of the spherical PDA particles is smooth, D) Particle size analysis confirms visual observation that a range of particle size is produces with particles predominantly in the 250-350 nm range.

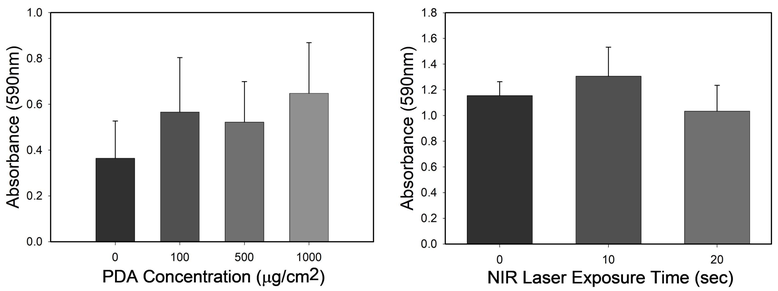


Figure 2. MTT assay of split-thickness skin grafts exposed to different concentrations of PDA (left) and to increasing exposures of NIR (right). PDA concentration up to 1000 ug/cm2 did not result in any decrease in metabolic activity, rather exhibited an increase in metabolic activity. Exposure to NIR for 10 and 20 seconds resulted in no statistically significant difference in skin metabolic activity.

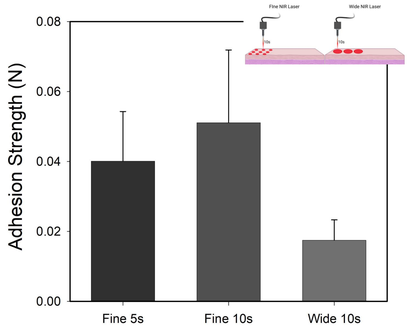


Figure 3. Strength of skin adhesion to the wound bed at 500ug/cm² PDA particles and different NIR laser patterns and times. Despite having lower total surface area coverage, the fine pattern improved adhesion strength likely due to more efficient tissue heating.

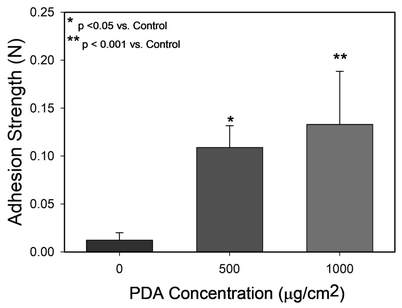


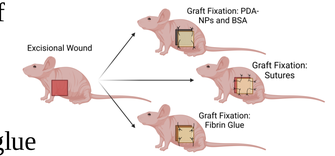
Figure 4. Strength of skin adhesion to the wound bed using the fine NIR laser pattern and increasing PDA concentrations. Both 500 and 1,000 ug/cm² significantly improved adhesion strength. For the in vitro mechanical tests, all samples were tested immediately after NIR laser exposure.

CONCLUSIONS

- PDA-NPs exhibit an average diameter of between 250 and 350nm
- PDA (100-1000ug/cm²) promote metabolic activity in skin
- A fine pattern of more intense exposure to NIR enhanced adhesive function
- Higher concentrations of PDA improved adhesion
- PDA particles may provide an alternative to more commonly utilize adhesives like fibrin glue

FUTURE WORK

- Comparison of PDA particles to fibrin glue in vitro
- In vivo study to characterize
  - Strength of adhesion using sutures alone, or with PDA particles or fibrin glue as a function of time
  - Assessment of inflammatory response with PDA particles versus fibrin glue



ACKNOWLEDGEMENTS

This research was supported by grant number 1R01AR080946-01A1 from the NIH/NIAMS.