Abstract #507 | Oral

Decellularized Small Intestine for Burn Wound Treatment: A Tissue Engineering Paradigm Shift?

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Introduction

Burn injuries are a major global health concern, estimated to cause 11 million injuries and 180,000 fatalities annually (1). The morbidity of burn injuries extends beyond the physical trauma, resulting in microorganism invasion, infection, and sepsis (1). Moreover, burn scars can compromise the quality of life, affecting joint mobility, functionality, and daily activities (2,3). Conventional dressings and autografts face limitations in healing, requiring the emergence of novel strategies (4). Xenographic tissue, after the adequate decellularization processing to cope with the low immunogenicity requirements, represents a unique avenue for developing advanced wound dressings. Porcine small intestine is characterized by its composition of fibroblast growth factors, transforming growth factor-beta, vascular endothelial growth factor, and structural and functional proteins. These components play pivotal roles in wound healing, regulating cell division, migration, and differentiation (5). To fully preserve these important bioactive molecules while ensuring its cost-effectiveness is an essential task, that can only be achieved by adequately designing tissue specific decellularization processes. This work proposes an advanced decellularization pipeline to obtain a safe and highly preserved porcine small intestine decellularized ECM, using combinatorial approaches and advanced technologies to achieve optimal tissue functionality as a wound dressing.

Methods

Porcine small intestines of 6-months pigs, were collected as a by-product from the agro-food industry and frozen at 20ºC. The cellular materials were removed from tissues by immersion and agitation with addition of a penetration enhancer (DMSO) to decrease tissue exposure time to detergents (SDS and SCD). Samples were tested to evaluate the decellularized ECM via hematoxylin–eosin (H&E) staining and DNA quantification. The mechanical properties were analysed via uniaxial tension testing using a texturometer. The samples' structure and morphology were characterized using SEM and histological analysis. Biocompatibility and adhesion assays are ongoing by direct contact assays using Human Dermal Fibroblasts.

Results

The proposed decellularization protocol produced a decellularized matrix that was first optimized and validated through H&E staining and DNA quantification. The optimized protocol was able to produce a decellularized tissue with a transparency (figure 1) and preserved mechanical properties when compared with the native tissue. The transparent nature of the decellularized matrix indicates a lack of cellular debris, supporting its potential for use in regenerative medicine applications. Morphological analysis revealed the different surface topographies of the intestinal matrix, showing an organized fibre structure in the serosa layer, and highly preserved and porous submucosa layer when compared with the native tissue (figure 2).

Conclusions

This work represented the first instance of the effective application of penetration enhancers for the decellularization of the intestinal matrix, reducing the duration of detergent exposure, and creating a transparent, superior-quality matrix with superior biological, structural, and biomechanical properties to cover a substantial portion of the human body for burn wound healing. Additionally, the efficiency of this method could lead to cost-effective treatments for a wide range of patients in need of skin grafts. Ongoing *in vitro* studies are being conducted to access the potential of each layer to interact with skin cells (fibroblasts and keratinocytes) in order to produce a more targeted application. By optimizing the interaction between the intestinal matrix and skin cells, this method has the potential to revolutionize the field of skin grafting and wound healing.

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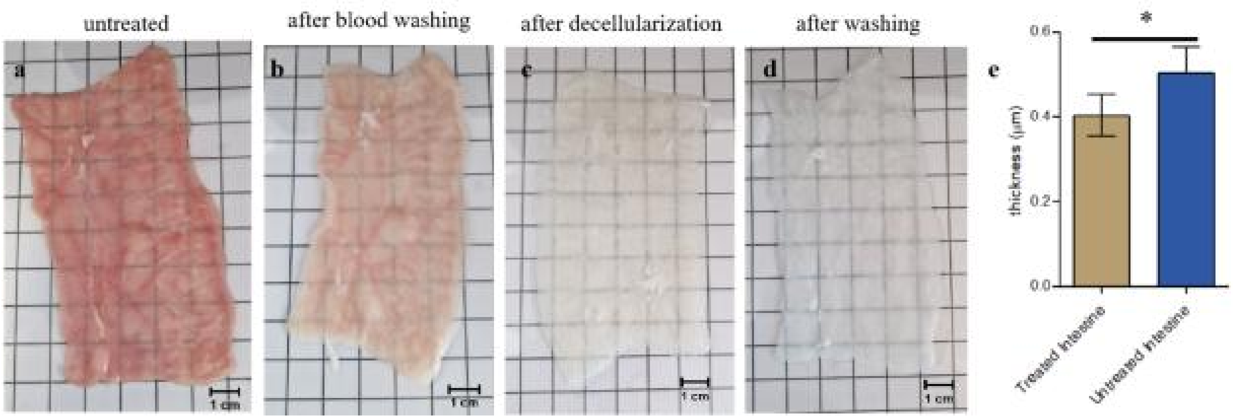

FIGURE 1

Bright field images of small instetine samples: (a) Untreated; (b) after blood rinsing (c) after decellularization and (d) after washing. Untreated and treated sample thickness (e). * significance found at $p < 0.05$.

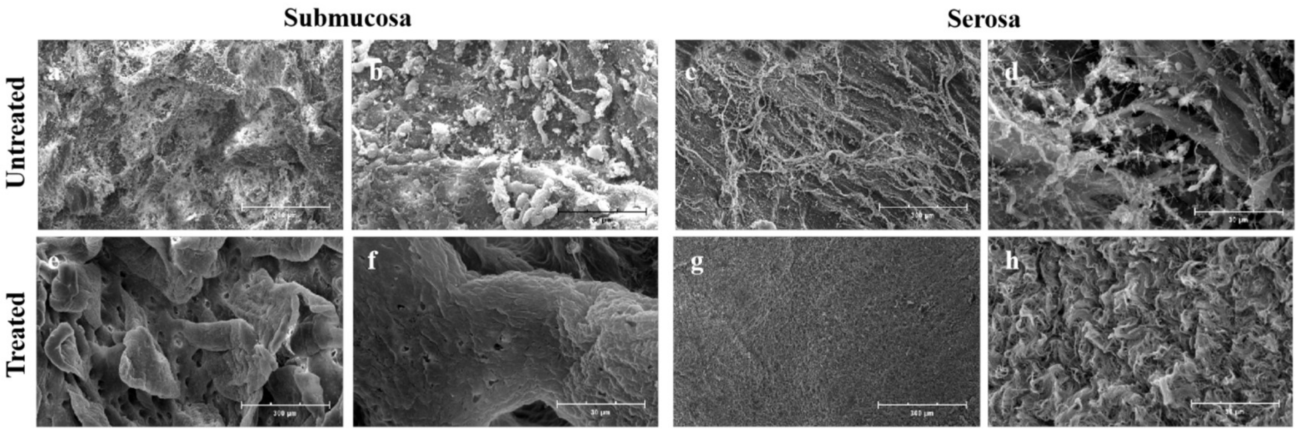

FIGURE 2

Figure 2. Scanning electron micrographs of the serosa and submucosa layer of small instetine samples: (a,b,c,d) untreated; (e,f,g,h) treated.