Mechanical properties of decellularized porcine esophagus: Preliminary results

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A B S T R A C T

Esophageal tissue engineering is a promising approach to create an esophageal substitute after surgical resection of a part of the organ. Regeneration of esophageal tissue may be achieved using some synthetic or biological scaffolds. In the present study, scaffolds are obtained through the decellularization of porcine esophagi. In view of future implantation, it is important to test the mechanical properties of the decellularized matrices and to compare them with the data obtained for native pig esophagi. Results of longitudinal and circumferential traction experiments as well as inflation and burst tests are presented. The results obtained for the compliance of porcine decellularized matrices are novel. It is concluded that the decellularized matrices are suitable for use as esophageal substitutes.

1. Introduction

Some esophageal pathologies require resection of a part of the organ. The resected tract can be replaced with autologous conduits made of in situ reshaped organs. However, this procedure is often associated with post-operative complications. Esophageal tissue engineering is a promising approach to create an esophageal substitute and improve clinical results in esophageal surgery. Regeneration of esophageal tissue may be achieved using some synthetic scaffold seeded with autologous stem cells [1,2,3]. Other studies aim to develop biological scaffolds composed of decellularized matrices (DM) [4,5,6,7,8]. DMs have the advantage to be very close to the native tissue and respect its architectural environment: native cellular elements are removed but the organ's mechanical and bioactive properties are expected to be kept. This is an essential requirement in view of substitute's implantation. It is thus important to test the mechanical properties of decellularized matrices and to compare them with the data obtained for native esophagi (NE). Besides, these characterization data may be useful for the understanding of the tissue physiology and pathophysiology and to address problems in surgery or in medical-device applications (surgical simulation or biopsy tools).

A detailed description of the esophagus wall composition is available in many papers [9–14]. Due to the organization of the tissue fibers, the esophagus wall presents some anisotropy. Consequently, traction experiments have been performed in the longitudinal and circumferential directions. Burst experiments have also been performed in order to evaluate the compliance and strength of the samples. Compliance of esophagus is important in vivo to withstand the physiological movements of esophageal tracts, but it has also to be stiff enough in order to prevent over-dilatation.

2. Materials and methods

2.1. Esophagi collection and preparation

Eosophagi were collected from 30 pigs (3 months ± 1 week old and 37± 5kg in weight) at the IHU Liryc in Pessac (33). These animals are included in heart research programs at IHU Liryc, and their esophagi would be in any case un-used. Some of the collected samples were kept apart as NE, and the others sustained a decellularization process. One may find a detailed description of this experimental procedure in [15–17]. Briefly, esophageal decellularization was performed according to a protocol based on the dynamic perfusion of chemical and enzymatic solutions (Sodium Azide, Sodium Deoxycholate, DNase, Sigma-Aldrich®) through the organ lumen. Efficiency of this protocol was checked by histological analysis and residual DNA quantification of the DMs. The ultrastructure of the DMs was analyzed using

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