6) Structural and morphologic evaluation of a novel detergent-enzymatic tissue-engineered tracheal tubular matrix.

Jungebluth P, Go T, Asnaghi A, Bellini S, Martorell J, Calore C, Urbani L, Ostertag H, Mantero S, Conconi MT, Macchiarini P. J Thorac Cardiovasc Surg. 2009 Sep;138(3):586-93; discussion 592-3. Epub 2009 Jul 14. PubMed PMID: 19698839.

Abstract

OBJECTIVE:

We sought to bioengineer a nonimmunogenic tracheal tubular matrix of 6 cm in length and test its structural, functional, and immunologic properties in vitro and in vivo.

METHODS:

Twelve-centimeter tracheal segments were harvested from Yorkshire boars. Half of each segment was subjected to a detergent-enzymatic method (containing sodium deoxycholate/DNase lavations) of decellularization for as many cycles as needed, and the other half was stored in phosphate-buffered saline at 4 degrees C as a control. Bioengineered and control tracheas were then implanted in major histocompatibility complex-unmatched pigs (allograft) or mice (xenograft) heterotopically for 30 days. Structural and functional analysis and immunostaining were performed after each detergent-enzymatic method cycle and transplantation.

RESULTS:

Compared with control tracheas, bioengineered matrices displayed no major histocompatibility complex class I and II antigens after 17 detergent-enzymatic method cycles, without significant ($P > .05$) differences in their strain ability (rupture force, 56.1 +/- 3.3 vs 55.5 +/- 2.4 N; tissue deformation at 203% +/- 13% vs 200% +/- 8% or 12.2 +/- 0.8 vs 12 +/- 0.5 cm; and applied maximum force, 173.4 +/- 3.2 vs 171.5 +/- 4.6 N). Thirty days after implantation, significantly ($P < .01$) smaller inflammatory reactions (392 vs 15 macrophages/mm(2) and 874 vs 167 T lymphocytes/mm(2)) and P-selectin expressions (1/6 vs 6/6) were observed in both the xenograft and allograft models with bioengineered matrices compared with those seen with control tracheas. There was no development of anti-pig leukocyte antigen antibodies or increase in both IgM and IgG content in mice implanted with bioengineered tracheas.

CONCLUSIONS:

Bioengineered tracheal matrices displayed similar structural and mechanical characteristics to native tracheas and excite no immune response to 30 days when implanted as allografts or xenografts. This method holds great promise for the future of tissue-engineered airway replacement.