Fabrication of Implantable Human Arterial Graft by Periodic Hydrostatic Pressure

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Keywords

Tissue engineering · Periodic hydrostatic pressure · Human vascular graft · Implantation · Mechanoresponse

Structural heart disease is the most common congenital anomaly, affecting almost 1% of live births [1]. Approximately 25% of newborns with congenital heart disease (CHD) require surgical or trans-catheter intervention in the first year of life [2]. Artificial materials such as polytetrafluoroethylene are used for the surgical repair of CHD, but these materials lack growth potential and lead to stenosis according to patient's growth. Therefore, biological tissue-engineered blood vessels are desired for pediatric patients. Recently, we fabricated implantable "scaffold-free" grafts consisting of rat vascular smooth muscle cells by periodic hydrostatic pressure (PHP) [3]. Here we aimed to fabricate implantable human grafts and examine the molecular response to PHP.

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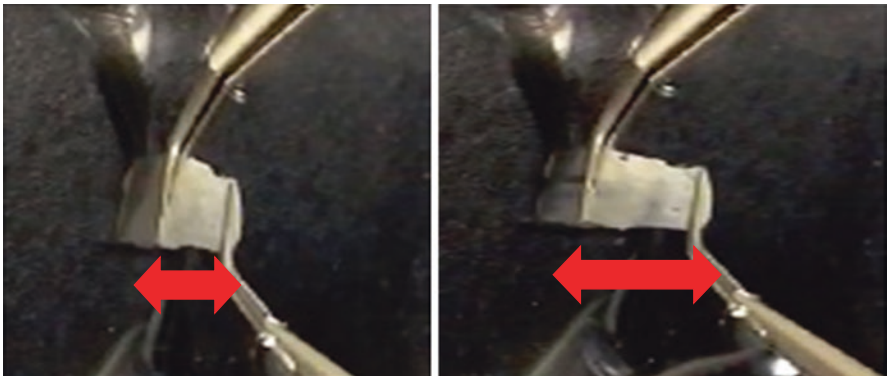

Fig. 46.1 Layered hUASMC showed elasticity

We seeded human umbilical arterial smooth muscle cells (hUASMCs) on a culture disk to make the first cell layer. Twenty-four hours after seeding, cells were exposed to PHP for 24 h, and then cells for the next layer were seeded on the top of the first layer, followed by repeating the same procedure to construct ten layered cell sheets. The multi-layered construct exhibited high elasticity (Fig. 46.1) and was successfully implanted at the aorta of nude rat. Echocardiography confirmed patency, and histological analysis demonstrated complete endothelialization.

We previously demonstrated that PHP promoted actin polymerization and fibronectin fibrillogenesis [3]. We further investigated the molecular response to PHP. hUASMCs were exposed to PHP and subjected to a microarray analysis. A microarray analysis revealed PHP-response genes, which are related to angiogenesis and stabilization of fibronectin. These genes were increased in a pressure-dependent manner, and co-localized with focal adhesion. These mechanoresponse molecules may contribute to construct the multi-layered cell sheets.

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