Improvement of biocompatibility of biomaterials by dopamine treatment

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Statement of Purpose: Cell attachment to biomaterials is a critical event in many biomedical applications such as tissue engineering. Since cells usually attach poorly on synthetic biomaterials, surface modification to promote cell adhesion has been the goal of many biomaterials studies. Recently, inspired from marine mussel' adhesive proteins, Messersmith developed a bioadhesive surface based on formation of a thin adherent polydopamine film by immersion of substrates in an alkaline dopamine (DOPA) solution [1]. In this study, we evaluated whether cellular affinity of a biomaterial could be enhanced by such dopamine treatment.

Methods: Polyurethane (PU), polycaprolactone (PCL) or poly(lactic-*co*-glycolic acid) (PLGA) dissolved in DMF was solvent-cast on 96-well polypropylene plates. DOPA solution (1 mg/ml in 10 mM Tris buffer, pH 8.5) was incubated with the polymer substrates for a certain period of time. After the substrates were rinsed with DI water, cells (primary rabbit chondrocyte, primary rat osteoblast, or human hepatoblastoma C3A cells) were seeded and cultured for 1 or 3 days. Cell numbers were determined by a lactate dehydrogenase assay. Albumin secretion by C3A cells was determined by immunofluorescent staining.

Results: DOPA modification enhanced chondrocyte adhesion to various biomaterials, such as PU, PLGA, and PCL (Fig. 1). Only 5-min incubation was sufficient to increase chondrocyte adhesion to several folds compared to pristine substrates. The enhancement in cell adhesion reach maximum after 10-min DOPA incubation. Furthermore, DOPA-treatment enhanced proliferation of chondrocytes or osteoblasts (Fig. 2). While proliferation of chondrocytes was retarded on PU, DOPA-treatment enhanced cell numbers to ~ 10 folds after 3-day culture. Similarly, osteoblasts grew much better on the DOPA-treated substrates.

DOPA-treatment also enhanced the adhesion and proliferation of C3A cells (Fig. 3a). Such promotion was correlated to the duration of DOPA treatment. The proliferation of C3A cells was greatly enhanced on the substrate treated with DOPA for 60 min. Furthermore, albumin secretion was more notable on the DOPA-treated surfaces (Fig. 3b). Compared to 5-min DOPA treatment, albumin expression on the substrate treated with DOPA for 60 min DOPA was much more apparent.

Here, we demonstrate that DOPA treatment is a simple and effective method for improving cellular adhesivity of synthetic biomaterials. This technique is not restricted to types of substrate or cells. Furthermore, cell functions might be enhanced by DOPA treatment.

Conclusions: DOPA treatment is an efficient way to increase cell adhesion and proliferation on biomaterials. This technique could benefit in many biomedical applications such as implants, tissue engineering and cell-based biosensors..

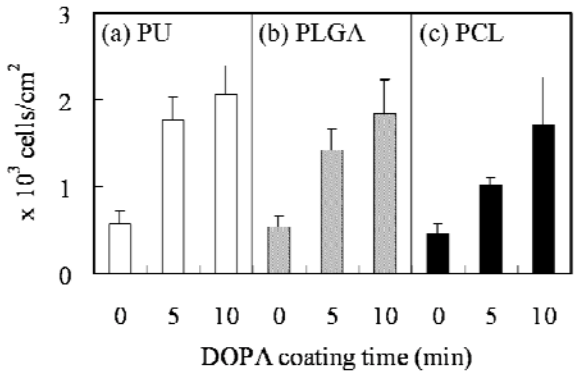

Fig. 1. Chondrocytes adhesion to PU, PLGA and PCL substrates after 1-day culture.

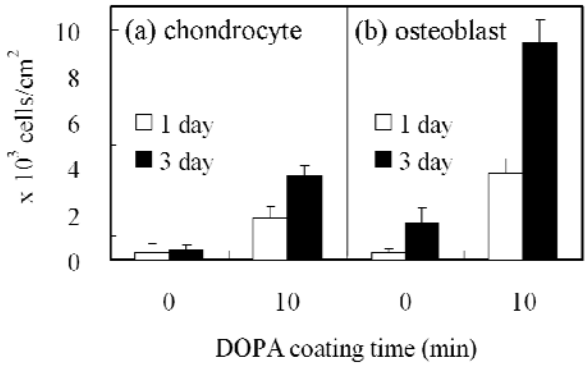

Fig. 2. Growth of chondrocytes and osteoblasts on PU substrates.

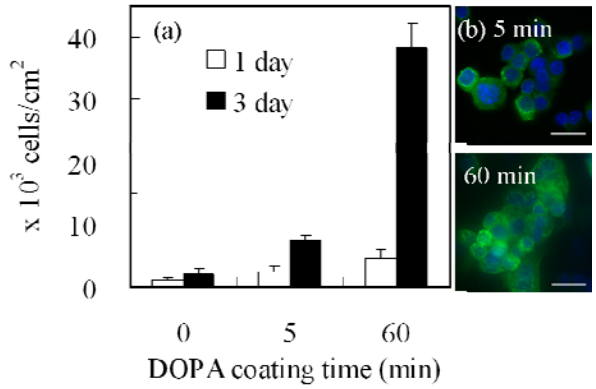

Fig. 3. a. Adhesion and proliferation of C3A cells on DOPA-modified PU. b. albumin expression on the DOPA modified PU on day 3. (Albumin: green; nuclei: blue).

References:

[1] Lee H et al. Science. 2007; 183:426-430.