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Control of focal adhesion dynamics by material surface characteristics

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Abstract

The mechanisms of cell adhesion to the extracellular matrix (ECM) which are of fundamental importance for function, survival, and growth of cells involve the formation of focal adhesions to facilitate integrin signaling. Recently, it became evident that focal adhesions are not stable but move to enable cell migration and ECM formation. We examined the number, size, and dynamic behavior of focal adhesions in living MG-63 osteoblastic cells, which were cultured on titanium surfaces with different roughnesses and on stainless steel (SS). As a marker for focal adhesions we used GFP-tagged vinculin, a cytoskeletal protein. Focal adhesions were smaller on titanium and on SS than on collagen-coated glass coverslips. The corundum-blasted rough surface of titanium induced the smallest adhesions. On all the surfaces that we have tested, we observed a mobility of focal adhesions. On collagen-coated coverslips focal adhesions moved with a speed of 60 nm/min. The speed was reduced on titanium and still more restricted on SS. The topography did not affect the mobility of focal adhesions. We conclude that on the material surfaces that we have studied a reduced mobility of focal adhesions may strengthen the linkages between cell and ECM but impair the ability to dynamically organize and remodel the ECM. The results may have a great impact in the functional evaluation of tailored biomaterial surfaces for the application in tissue engineering.

Keywords: Osteoblast; Titanium; Surface topography; Vinculin; Focal adhesion; Mobility