'Nano-bumps' could help repair clogged blood vessels

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Biomedical engineers at Purdue University have shown that "vascular stents" used to repair arteries might perform better if their surfaces contained "nano-bumps" that mimic tiny features found in living tissues. The researchers already have shown in a series of experiments that bone and cartilage cells in petri dishes attach better to materials that possess smaller surface bumps than are found on conventional materials used to make artificial joints. The smaller features also stimulate the growth of more new bone tissue, which is critical for the proper attachment of artificial joints once they are implanted.

Now the biomedical engineers have seen the same kind of increased attachment for endothelial and vascular smooth muscle cells lining the insides of arteries, said Thomas Webster, an associate professor of biomedical engineering at Purdue.

The stents are small metal scaffolds that are inserted inside arteries to prop them open during or after surgery to remove dangerous plaque deposits from the vessels. The stents, which are made of titanium and other metals, enable the arteries to grow new tissue after vessel-clogging plaque deposits have been removed. A major problem, however, is that the body often perceives the metal devices as foreign invaders, hindering endothelial cells from attaching to the scaffolding and prompting the creation of scar tissue, which can build up inside blood vessels and interfere with blood flow.

"If a stent doesn't attach firmly it can become loose, and parts of it will actually break off and go down the bloodstream," Webster said. "Essentially, what we've been trying to do is find new materials that cause the endothelial cells to attach better to these stents without creating as much dangerous scar tissue."

The researchers tested discs of titanium containing surface bumps about as wide as 100 nanometers – or billionths of a meter. The metals used to make conventional stents have features about 10 times larger or none at all. The nanometer-scale bumps mimic surface features of proteins and natural tissues, prompting cells to stick better, Webster said.

"Ideally, you want endothelial cells to quickly attach to stents and form a coating only one cell layer thick, which we call a monolayer," Webster said. "Otherwise, if the metal is not entirely coated, blood cells passing through the repaired artery come into contact with the metal and recognize it as foreign."

Findings will be presented on April 28 during the Society for Biomaterials' 2005 Annual Meeting and Exposition in Memphis, Tenn. The work was conducted by graduate student Saba Choundhary, Webster and Karen Haberstroh, an assistant professor of biomedical engineering.

The researchers placed titanium discs possessing the nano-features into petri plates containing a suspension of endothelial cells. After one hour, the discs were washed and a microscope was used to count how many of the dyed cells adhered to the material. The researchers found that nearly three times as many cells stuck to the discs containing the nano-bumps, as compared to ordinary titanium.

"After one hour, we get three times more endothelial cell coverage of the metal if it has nano- features," Webster said.

Numerous surgeries involving stents are performed annually worldwide, with sales of "vascular biomaterials" adding up to more than $1 billion each year.

The research has been funded by the National Science Foundation. Webster's lab is affiliated with the Birck Nanotechnology Center and the Bindley Bioscience Center, which are in Purdue's Discovery Park, the university's hub for high-tech research.

Further research is planned that will replace the titanium disks with tube-shaped pieces of the nano-featured metal, which will resemble the actual shape of real stents.

Source: Purdue University