Researchers successfully test model for implant device reactions

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(Medical Xpress)—A team from the University of Texas at Arlington has used mathematical modeling to develop a computer simulation they hope will one day improve the treatment of dangerous reactions to medical implants such as stents, catheters and artificial joints.

The work resulted from a National Institutes of Health-funded collaboration by research groups headed by Liping Tang, professor of bioengineering in the UT Arlington College of Engineering, and Jianzhong Su, chairman and professor in the UT Arlington College of Science's mathematics department.

Results from their computational model of foreign-body reactions to implants were consistent with biological models in lab tests. A new paper describing the results has been accepted for publication in the Journal of Immunological Methods.

"Our efforts have transformed complex and dynamic biological interactions and pathways into a simplified mathematical formula," said Tang. "This model will allow us to improve the biocompatibility of medical devices and identify the timing and dosages of treatments when reactions occur."

Other co-authors on the study were Jichen Yang, a visiting scholar of mathematics at UT Arlington, Larrissa Owens, a PhD student and National Science Foundation GK-12 fellow in mathematics, and Akif Ibraguimov, professor in the department of mathematics and statistics at

Texas Tech University.

Almost all medical implants cause some degree of foreign body reaction, which can cause severe inflammation and the formation of fibrotic capsules in surrounding tissue, according to the paper. These conditions can compromise the device's effectiveness. The reaction's severity is governed in large part by the behavior of microphages, cells that can rapidly change in response to signals from the body and its immune system.

The research team divided microphages into three types based on their functions. Then, they constructed a series of mathematical equations based on the kinetic characteristics of the microphages and fibroblasts, or connective tissue. Su said reviewing results available from wound healing, especially at the skin's surface, helped increase the accuracy of their calculations.

"Foreign body reactions are very complex, involving many cells, proteins and other biological elements. The experimental measurement data are really scarce to capture the entire process," Su said. "We overcome this difficulty by learning from what happens in wound healing, a similar biological process."

The cross-disciplinary collaboration between Su and Tang is the kind of effort necessary for far-reaching scientific advances, said Carolyn Cason, UT Arlington's vice president for research.

"Research universities such as UT Arlington are at their best when they bring together great thinkers and encourage them to reach outside their academic silos to solve scientific questions," Cason said.

The new paper is called: "A computational model of fibroblast and macrophage spatial/temporal dynamics in foreign body reactions."

Su and Tang plan to continue their research by addressing some of the biological conditions unique in patients that could affect wound healing and foreign body interactions. Those calculations could make their model more reliable, they said.

More information: www.sciencedirect.com/science/ … ii/S002217591300238X

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