The Faculty of Engineering

POPULAR SCIENTIFIC ABSTRACT

[Anders Runge Walther]

[In Situ Raman Analysis of Resorbable and Drug Loaded Implants]

The ultimate goal of tissue engineering and regenerative medicine is to develop biological substitutes to replace tissue and organs lost through trauma and disease. A general approach to the production of engineered tissue is to combine stem cells with a biodegradable scaffold that can be implanted into the patient. The scaffold provides mechanical stability while the cells produce new tissue. The mesenchymal stem cells possess the ability to become specialized cells, capable of producing certain types of tissue, such as bone and cartilage. By tuning the mechanical, physical, and chemical properties of the scaffold it is possible to direct the stem cell towards the desired tissue type. New tissue engineering strategies are often tested and validated by experiments performed in the petri dish or live animals. Whether one or the other method is used, monitoring the cells, tissue, and scaffold at all stages of the engineering process is important to ensure that the desired tissue outcome is achieved. Currently available methods for assessing engineered tissue suffer from several drawbacks such as being destructive, invasive, requiring extensive sample preparation, labeling, or only capable of revealing structural information.

In Raman spectroscopy, the sample is illuminated by a laser often without damaging it. The reflected light contains information about the molecules in the sample. In biomedical research, the technique can be used to reveal the presence of proteins, lipids, carbohydrates, and DNA. Thus, Raman spectroscopy could potentially be an important tool for monitoring engineered tissue to ensure the correct composition of these biomolecules is achieved.

In the current project, Raman spectroscopy was applied and developed within three areas of tissue engineering. First, the technique was used for characterizing newly formed dentine in tooth defects. In combination with microscopy, it was possible to determine how similar the new dental tissue was to native dentine on the content of protein and mineral. Secondly, a combined Raman spectroscopy and microscopy technique was developed for studying stem cells and their production of biomolecules in a resorbable cartilage substitute. The technique was compared to commonly used fluorescence microscopy. Finally, a Raman spectroscopic system was developed and applied for studying tissue formation in a novel resorbable bone scaffold implanted in live mice. The results showed that it was possible to follow the gradual increase in collagen (main organic component of bone) over time for scaffolds containing stem cells. Scaffolds without stem cells showed a non-specific lipid-rich tissue type. Thus, the technique is useful for monitoring engineered tissue in live animals and testing novel resorbable implants.