BIOSCIENTIST
The Salford Biomedicine Society Magazine

Biomaterial that heals tissue from the inside out

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Have you ever wondered if we could heal tissues in the body from damage that can be detrimental? In December 2022, a journal on Nature, brought to light from the University of California San Diego, discovered a new biomaterial that can heal tissues from the inside out[1,3]. Karen Christman, professor of bioengineering at the University of California San Diego and the lead researcher for the team who developed the biomaterial, stated, “It is a new approach to regenerative engineering[1].”

Christman and colleagues developed a hydrogel produced from the natural scaffolding of cardiac muscle tissue known as the extracellular matrix (ECM)[1]. This can be injected into the damaged heart tissue via a catheter, forming a structure in damaged areas of heart tissue, assisting in new cell growth and cell repair[1]. However, this hydrogel needed to be injected directly into the heart as well as using the hydrogel only one week or more after a heart attack – due to needle-based injection procedures, this caused a risk of damage[1]. This biomaterial was tested, and it has effectively treated tissue damage caused by heart attacks in rodents and large animals[1]. Initial proof of concept in rodent models strongly suggests that the biomaterial could potentially be beneficial to patients with traumatic brain injury and pulmonary arterial hypertension[1]. Christman stated that studies to test the safety and efficiency of the biomaterial on human subjects could start within one or two years[1].

In the USA, approximately 785,000 new heart attack cases arise every year[1]. When a person recovers from a heart attack, they are left with scar tissue and muscle function decline leading to congestive heart failure. Currently, there are no treatments for repairing cardiac tissue damage[1].

How is this biomaterial created?

Initially, researchers in Christman’s laboratory used hydrogel they developed that enabled intravenous injections as part of safety trials[1]. However, the hydrogel particles were too large to target leaky blood vessels, this was resolved by a PhD student Sprang by centrifuging the hydrogel particles into nanoparticle size[1]. The liquid ECM hydrogel was centrifuged at 15,000 RCF at 4°C for 45 minutes, which separated the bigger-sized particles away to extract only the nano-size particles[1,2]. After centrifuging, the supernatant iECM (infusible ECM) was out through dialysis, then sterile filtering, and finally, freeze-dried[1,2].

How does this biomaterial work?

Patches of decellularised extracellular matrix and locally injected hydrogels have been used as therapies in animal models of disease[2].

Instead, the biomaterial bound to the endothelial cells forces the gap to close and increases the speed of healing in blood vessels[1]. This helped reduce inflammation, equivalent results occurred when researchers tested the biomaterial on porcine models of heart attack[1]. Various assays were performed to comply with

DOI: https://doi.org/10.57898/biosci.71

evidence, and iECM was found to be haemocompatible – meaning being compatible in the presence of blood. This was tested using 1:1 iECM to human blood and physiological concentrations of 1:10 iECM, with immediate dilution with blood, then infusion[2]. As a result, Prothrombin times, RBC aggregation, and Platelets aggregation with agonists were within the physiological ranges[2]. IECM has been shown to bind to inflamed endothelium, reduce vascular leakages and increase vascular healing[1,2].

Figure 1: *The biomaterial is based on the hydrogel that was produced in Christman's laboratory*[1,3].

For the future?

Christman and Ventri Bio, Inc., are now amid seeking FDA approval to conduct a study on human hearts of the biomaterial's applications in heart conditions[1].

References

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DOI: https://doi.org/10.57898/biosci.71