Fucoidan’s Novel Role in Tissue Repair and Heart Health

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The controversial discussions about stem cells that we hear in the news often revolve around the potential ability of embryonic stem cells to treat diabetes, cancer, cardiovascular disease, Alzheimer’s, Parkinson’s, autoimmune disease, burn victims, blood diseases, leukemia, and spinal injuries. Yet, adult stem cells already within our bodies play an equally important role in health regardless whether we are healthy or suffering from any of a number of health conditions.

Stem cells are the tool repair kits of the human body. They initiate true cellular healing of aging tissues and organs as well as reinvigorate tissues damaged by disease, toxins or trauma. Found in all multi-cellular organisms, stem cells renew themselves through mitotic cell division and can differentiate into a diverse range of specialized cell types. In the 1960s, Canadian scientists Ernest A. McCulloch and James E. Till were the first to extensively research these remarkable cells.1-2

There are two primary types of mammalian stem cells: embryonic stem cells and adult stem cells that are found in adult tissues. In a developing embryo, stem cells can differentiate into all of the specialized embryonic tissues. In adults, stem cells and progenitor cells help to repair the body, replenishing specialized cells and maintaining the normal turnover in regenerative organs, such as blood, skin or intestinal tissues. Stem cells mobilize to a diseased or injured site where they repair or replace damaged tissue. Remarkably, this means they have the ability to reverse disease and injury. After a heart attack, for example, stem cells can replace damaged heart muscle with new muscle cells.

For a cell to be considered a stem cell it must meet two requirements. First, it must have the ability to renew itself. Second, it must have potency, meaning it is capable of differentiating into specialized cell types. Embryonic stem cells are true stem cells in that they are pluripotent and show unlimited capacity for self-renewal. In contrast, many cells termed adult stem cells would be better defined as progenitor cells. For the purposes of this article I will use the terms stem cell and progenitor cell interchangeably.

Basically, a stem cell is simply a cell that has the ability to regenerate tissue over a lifetime. Bone marrow stem cells or stem cells that assist in the production of blood cells can be transplanted into an individual without these stem cells. In this case, a stem cell must be able to produce new blood cells and immune cells over a long term, demonstrating potency. It should also be possible to isolate stem cells from the transplanted individual, and transplant those cells into another individual lacking the stem cells, proving that the stem cells could self-renew.

Because stem cells play such a powerful part in our body’s ability to heal, finding a substance to enhance their action can have dramatic consequences on many aspects of health. Recent research indicates that a marine algae known as fucoidan may be such a substance.

Fucoidan, Stem Cells and Cardiovascular Health

In 1997, progenitor cells were first identified in human peripheral blood, meaning the cells were traveling in the blood stream rather than remaining static. Mobilization of these cells to ischemic sites is an important step in new vessel formation. After a period of ischemia—when blood vessels and cardiac tissue are injured due to lack of oxygen—these progenitor cells migrate from the bone marrow to the
site of injury and encourage the growth of new blood vessels to help repair the damage, a process known as neovascularization. It is thought that the progenitor cells interact with endothelial cells (cells lining blood vessel walls), then escape from the vessels into the tissues to reach ischemic sites, where they proliferate and differentiate into new blood vessels.

Fucoidan—a sulfated polysaccharide extracted from brown seaweed—is now thought to have a role to play in this stem-cell-induced repair of cardiovascular damage. Studies have begun to emerge indicating fucoidan might influence the mobilization of endothelial progenitor cells and their incorporation in ischemic tissue.3

Studies have shown that treatment with the sulfated polysaccharide fucoidan or the structurally similar dextran sulfate increases circulating mature white blood cells and progenitor/stem cells in mice and nonhuman primates. Recent studies suggest that fucoidan may work by enhancing the activity of stromal-derived factor 1 (SDF-1), which plays a critical role at several steps of progenitor cell mobilization.

Researchers reporting in the journal Blood recently discovered that plasma concentrations of the highly potent SDF-1 increased rapidly and dramatically after treatment with fucoidan in monkeys and in mice, coinciding with decreased levels in bone marrow. In vitro and in vivo data suggest that fucoidan displaces certain factors that normally trap the SDF-1 in bone marrow, on endothelial cell surfaces or other tissues, helping to release the SDF-1 and allowing it to more easily mobilize the stem cells. The researchers tested other mobilizing agents to see if they would have the same effect but fucoidan was the only substance tested able to increase SDF-1 activity and enhance stem cell mobilization to sites of injury.4

Endothelial progenitor cells, when transplanted into animals, are able to increase the formation of new blood vessels to a certain extent. However, in this case, the number of circulating endothelial progenitor cells is relatively small. Therefore, researchers in France decided to investigate whether fucoidan could empower the blood-vessel-building properties of the stem cells prior to injection in vivo. During this in vitro study, the scientists found that fucoidan could indeed enhance the proangiogenic (blood-vessel-building) properties of endothelial progenitor cells, indicating that it can enhance the cells’ ability to mobilize and repair damaged tissue.5

In another study, scientists used a rat model of atherosclerosis to test the effects of fucoidan on lesions on the inner lining of the arteries called the intima. The study authors transplanted atherosclerotic aortas into the animals. In animals given fucoidan, the proliferation of intimal lesions was significantly prevented compared to controls and fucoidan appeared to trigger a reduction in intimal thickening. Furthermore, fucoidan helped stimulate the rebuilding of the endothelial cells in the grafted aorta. Treatment with a specific inhibitor of the SDF-1 receptor failed to prevent the protective effect of fucoidan on intimal thickening, indicating fucoidan’s effects in this study were not attributable to increased SDF-1 activity.6

The researchers concluded that fucoidan “reduced intimal thickness and induced the presence of an endothelial cell lining in the vascular graft at 30 days.”
Multi-Functional Nutrient from the Sea

Fucoidan’s emerging ability to enhance the activity of stem cells adds to an impressive list of other potential uses for this substance. It appears to exert a number of other beneficial effects on the cardiovascular system. It possesses anticoagulant abilities.7 Fucoidan also is known to block selectins, cell receptors important in the adhesion of white blood cells known as leukocytes to capillary walls.8 When leukocytes adhere to the blood vessel walls, it can lead to tissue damage, ultimately resulting in atherosclerosis.

Fucoidan has been studied extensively for its ability to strengthen the immune system, and in a number of in vitro and animal studies, it has inhibited coated viruses such as herpes, HIV and human cytomegalovirus, a type of herpes virus that can cause blindness and fatal pneumonia in individuals with compromised immune systems. Experiments have suggested that fucoidan may not only inhibit the initial stages of viral infection, such as attachment to and penetration into host cells, but also the later replication stages after virus penetration.9

A newly published cell culture study also indicates fucoidan may reduce acute and chronic liver failure and liver fibrosis and may protect liver cells from damage.10

Despite fucoidan’s ability to promote blood vessel growth, the medical literature shows it is non-mutagenic and that it can actually inhibit cancer growth. Fucoidan is known to enhance the activity of natural killer cells, which seek out and destroy tumor cells and are a critical defense against malignancies. In a study investigating fucoidan’s effects on the tumor growth of mouse leukemia cells, animals fed fucoidan experienced a 65.4 percent inhibition of tumors. Additionally, natural killer cell activity significantly increased in the fucoidan-fed mice compared to animals fed a normal diet.11

Fucoidan also stimulates an increase in levels of interferon gamma, which generates increased immune activity during infections and cancer states.12-13 Furthermore, it can inhibit hyperplasia (abnormal cell overgrowth) in rabbits14 and induce apoptosis (spontaneous, programmed, cancer cell death) in human lymphoma cell lines.15

Conclusion

Enhancing the activity of adult stem cells clearly is crucial to the proper functioning of the cardiovascular system. Unless these cells are functioning effectively, the body is unable to properly repair itself after injury. Fucoidan is a novel, marine-derived natural substance well researched for its immune enhancing abilities and now known to help mobilize stem cells, thereby enhancing cardiovascular and overall health.

References:
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