Adipose-Derived Stem Cells as an Alternative to Bone Marrow Stem Cells in Regenerating Heart Muscle Tissue

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Introduction

Myocardial infarctions, or heart attacks, cause long term damage to the muscle in the heart and further increase heart risk through negative restructuring of the heart. Over seven million people are affected by heart attacks per year (Mozaffarian et al., 2015). Heart attacks are caused by a shortage of oxygen to the heart, which can originate from blood clots where blood flow is reduced or completely blocked off due to the buildup of cholesterol. The development of cholesterol blocks and limits conduits which alludes to a blockage in blood vessels throughout the body.

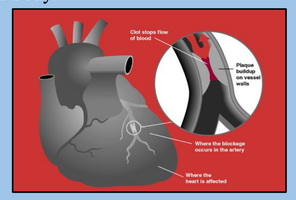

Fig. 1 This picture shows the plaque building in the blood vessels reducing their lumen; this may lead to restricted blood flow and cause heart attacks (U.S. Food and Drug Administration).

Stem cells are cells equipped for separating, cloning, or self replicating into different types of cells. They intend to supplant dead or harmed typical cells to keep the organ or tissue healthy. The stem cells themselves are unspecialized, however rather offer replacement to particular cells. These cells are important in every organism since blood, nerve, or muscle cells can't replicate themselves. There are numerous areas around the body where stem cells can be derived For instance, in flowing blood, lipid cells, or bone marrow (Chen et al., 2004). Grown-up bone marrow undeveloped cells (BMC) have been utilized in preliminary studies involving cardiovascular repair (Stamm et al 2003; Grajek et al., 2009).

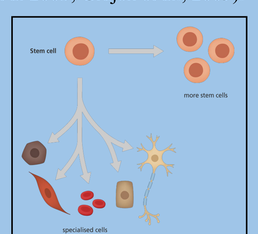

Fig 2. The figure shows a single stem cell and its potential to differentiate and be used for different purposes in the human body (What is a Stem Cell?).

Most eminent among these are, mesenchymal cells (MSC) and hematopoietic undifferentiated cells (Heldman et al., 2014). Mesenchymal cells are cells that can differentiate into different cell types such as osteoblasts, chondrocytes, myocytes, and adipocytes.

Abstract

This paper analyzed the effectiveness of adipose-derived stem cells in regenerating heart muscle tissue and improving cardiac function. Results were compared to bone marrow stem cells, another stem cell with similar characteristics, to determine which stem cell is more effective at repairing cardiac tissue. The results showed no significant values when using bone marrow stem cells and adipose-derived stem cells in rats but presented significant values when bone marrow stem cells were used in clinical trials. Considering these findings, adipose-derived stem cells were more effective than bone marrow stem cells in repairing a rat's heart and have the potential to produce results better or similar to that of bone marrow stem cell transplantation in humans.

Hypothesis

Alternative: Adipose-derived stem cells are more effective than bone marrow stem cells in repairing heart muscle tissue after infarction.
Null: Bone marrow stem cells are as effective as adipose derived stem cells in repairing heart muscle tissue after myocardial infarction.

Research Question

Are adipose-derived stem cells more effective than bone marrow stem cells in regenerating heart muscle tissue after infarction?

Purpose

The purpose of this study is to determine the effectiveness of bone marrow stem cells compared to adipose derived stem cells as a treatment for myocardial infarctions. Finding the more effective stem cell will increase the lifespan of the heart cells which will extend and improve a person's quality of life.

Methodology

The study utilized a systematic review to find the effectiveness of bone marrow stem cells versus adipose derived stem cells in repairing infarcted areas of the heart. Results were from the use of stem cells in treating heart muscle tissue in both humans and rats after myocardial infarctions. The data collected from articles included the ejection fraction, infarcted area, end systolic volume, and end diastolic volume before and after implementation. Statistical analysis was carried out using a t-test.

Results

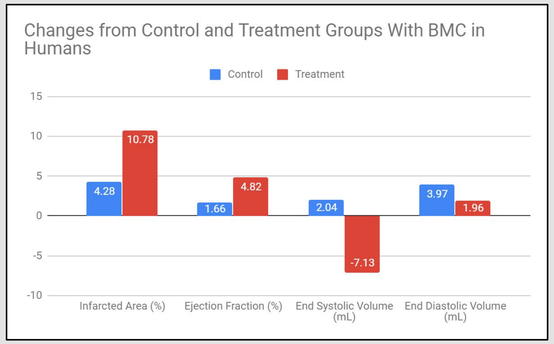

Figure 3. The figure above is a comparison of average IF, EF, ESV, EDV change in control and treatment groups involving bone marrow stem cell transplantation in humans.

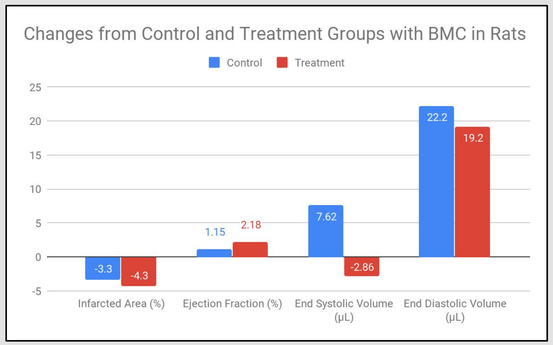

Figure 4. The figure above is a comparison of average IF, EF, ESV, and EDV change in control and treatment groups involving bone marrow stem cell transplantation in rats.

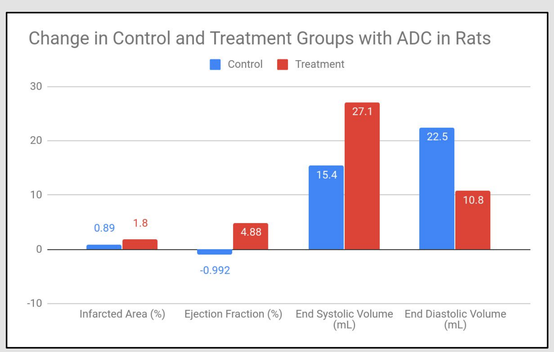

Figure 5. The figure above is a comparison of average IF, EF, ESV, and EDV change in control and treatment groups involving adipose-derived stem cell transplantation in rats.

Discussion

Regarding BMC transplantation in clinical trials, results were positive and showed promise. There was a decrease in IF meaning that the area affected by the heart attack decreased. Furthermore, the EF increased, showing an increase in the amount of blood entering and exiting the heart during a contraction. Furthermore, there was a difference in ESV meaning that more blood is exiting the heart after a contraction. However, the EDV did not produce positive results.

As for BMCs in rats, the results showed insignificant values meaning the stem cell may have little no effect on a rat's heart. The EF, ESV, and EDV all revealed meager changes. In fact, the p-values for all three categories were over 0.05. Ultimately, BMC transplantation in rats as a whole was inconsequential for improving cardiac function.

For ADCs in rats, the results were slightly better than BMCs in rats but overall still insignificant. Nevertheless, the EF had an average increase of 5.87 percent. Correspondingly, the ESV and EDV using ADCs were more significant than BMCs. Nevertheless, the p-values for all three categories were greater than 0.05 and thus insignificant.

Conclusion

Although bone marrow stem cells in rats were ineffective, bone marrow stem cells in humans were very effective. It showed promise in increasing ejection fraction and end diastolic volume while decreasing end systolic volume. As for adipose-derived stem cells in rats, infarcted area was not acquired in almost all articles and the changes between the ejection fraction, end systolic and diastolic volume, from the control to treatment groups were insignificant. Since the qualities of the two stem cells in rats were very similar, the use of adipose-derived stem cells might produce similar results to bone marrow stem cells when used clinically.

Further Work

Future study work should be larger sample sizes over longer periods of time. A variety of tests need to be carried out because a patient's and rat's background in terms of health issues are all factors that affect the procedure as a whole. In addition, more clinical trials using adipose-derived stem cells as the method of treatment are needed to clearly show the differences between the two stem cells in humans.

Acknowledgements

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