METHOD OF PREPARING NEUTROPHIL-DEPLETED PLATELET-RICH PLASMA

RELATED APPLICATIONS

This application is a continuation of U.S. application Ser. No. 12/265,232, filed Nov. 5, 2008 which is a divisional of U.S. application Ser. No. 11/205,283, filed Aug. 16, 2005, now U.S. Pat. No. 7,462,268, issued Dec. 9, 2008 which claims priority to U.S. Application No. 60/603,249 filed Aug. 20, 2004. All of the above applications are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

In one embodiment, the invention relates to a particle or cell separation device that separates specific cell types such as neutrophils or stem cells or particles from bodily fluids such as platelets and other blood products such as red cells and plasma. Also encompassed are the bodily fluids which have been processed through the disclosed device, particularly compositions which are enriched in platelets and depleted in neutrophils.

2. Description of the Related Art

Several devices are now on the market that can process a small amount of peripheral blood (20-60 cc) automatically or semiautomatically into a fraction of that plasma that is rich in platelets. The material obtained from these devices is known as platelet rich plasma or platelet concentrate. This material is being used to augment bone grafting or to initiate soft tissue healing (See U.S. Pat. No. 6,811,777, which is incorporated herein by reference). The basis of this healing is likely due to the high concentration of growth factors found with platelets. It has been established, however, that some of the cells in platelet rich plasma may adversely affect healing or even cause further damage (Iba et al Circulation October 2002). Specifically, the neutrophils (a type of white blood cell also known as polymorphonuclear cells) contain a variety of powerful enzymes that can cause tissue inflammation. These may be present at levels of $1-3\times10^9$ per unit of whole blood and it is postulated by the inventor that removal of the neutrophils from the platelet rich plasma or whole blood may have significant value.

Importantly, neutrophils are also considered to be harmful in blood transfusions. Several devices already exist that attempt to filter or reduce the concentration of neutrophils prior to transfusions. Further, during cardiovascular bypass surgery when a patient's blood is pumped via a machine for a period of time, the perfusionist may attempt to filter out the neutrophils. Some evidence suggests that there is a better survival rate for patients that have these cells removed during the procedure. The reason for the increased survival is a lower rate of pulmonary complications after surgery. Presently, however, these filters only work incompletely and are not functional for small volumes of blood. A recent experiment involving platelet rich plasma revealed a 96% reduction in total platelet concentration when using a commercially available neutrophil reduction filter. Sixty percent of the volume (3 out of 5 cc) was also trapped in the filter (Mishra, data on file 2003). Clearly, this filter would not be helpful for specifically reducing neutrophils in platelet rich plasma. What is needed is a device that is effective in separating out neutrophils for both small and large volumes of blood while maintaining the platelet concentration. Presently, this device does not exist. Also, no available device mimics the body's own ability to filter neutrophils. This leads to the concept behind a new physiologic neutrophil separation device.

SUMMARY OF THE INVENTION

In one embodiment, the present invention is directed to a cell separation device which includes an inlet end portion including an inlet port for receiving a fluid sample; an outlet end portion including at least one collection port for removing separated components of the fluid sample; and a flow path comprising a tubular material in fluid communication with the inlet end portion and the outlet end portion. Preferably, the tubular material is latticed or coiled and is made of plastic or silicon.

In a preferred embodiment, the flow path is placed within an electric field. Preferably, the tubular material is charged. In some embodiments, the outlet end has a positive charge and the inlet end has a negative charge.

In some embodiments, the cell separation device is part of a larger system that includes a blood filtering device. Preferably, the blood filtering device is adapted for platelet enrichment such as production of platelet rich plasma.

Also encompassed within the scope of the invention are compositions produced by the described device. Preferably, compositions produced by the device have a reduced neutrophil content. In a preferred embodiment, the composition includes whole blood or platelet rich plasma in which the neutrophil content has been reduced by 10% or more. Preferably, the composition is neutrophil-depleted whole blood or platelet rich plasma, wherein a neutrophil content has been reduced by at least 5% compared to a starting material. More preferably, the neutrophil content in the neutrophil-depleted whole blood or platelet rich plasma has been reduced by at least 10% compared to a starting material.

In one embodiment, the invention is directed to a device for separation of neutrophils from platelet rich plasma including an inlet end portion including an inlet port for receiving a sample of platelet rich plasma; an outlet end portion including at least one collection port for removing neutrophil-depleted platelet rich plasma; and a flow path which includes a tubular material in fluid communication with the inlet end portion and the outlet end portion. Preferably, the tubular material is latticed or coiled.

In one embodiment, the invention is directed to a method of preparing neutrophil-depleted platelet rich plasma including the steps of obtaining a blood sample from a patient; obtaining platelet rich plasma from the blood sample; passing the platelet rich plasma through the cell separation device described above to obtain neutrophil-depleted platelet rich plasma; and collecting the neutrophil-depleted platelet rich plasma.

In an alternate embodiment, the invention is directed to a method of preparing neutrophil-depleted platelet rich plasma including the steps of obtaining a blood sample from a patient; passing the blood sample through the cell separation device described above to obtain neutrophil-depleted blood; and processing the neutrophil-depleted blood to obtain neutrophil-depleted platelet rich plasma.

Embodiments of the invention are directed to methods of treating an injured tissue in an individual which include at least one of the steps of determining a site of tissue injury in the individual; and introducing a neutrophil-depleted platelet-rich plasma composition into and around the site of tissue injury. In preferred embodiments, the tissue is connective tissue, cardiac muscle, skeletal muscle, disc material, a ver-