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Umbilical Cord Blood Preservation and Its Future Benefits

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Mini Review

ABSTRACT

Umbilical cord blood preservation has been the focus of many medical aspects as it can provide a virtually unlimited source of ethnically-diverse stem-cell. It contains haematopoietic (blood) stem cells: rare cells normally found in the bone marrow. Haematopoietic Stem Cells (HSCs) can make every type of cell in the blood – red cells, white cells, platelets, nerve cells, bone cells and organs. They are responsible for maintaining blood production throughout our lives. Stem Cells are today used in the treatment of over 80 medical conditions including Blood Disorders, cancer, Immune Disorders and metabolic disorders.

Keywords: Stem cell, Umbilical cord, Treatment of cancer, Blood disorders

INTRODUCTION

Stem cells in the umbilical cord blood are capable of repair and self-renewal of damaged cells and thus used in the treatment of various medical conditions. At present, umbilical cord stem cell therapy is used in many on-going clinical trials and research studies to treat the patients and understand the disease mechanism to provide better therapies. Stem cell based therapies are increasingly being utilized with promising results in both malignant and non-malignant disorders [1-4]. Three sources of cells have been used for haematopoietic reconstitution – bone marrow (BM), Peripheral Blood (PB) and Umbilical Cord Blood (UCB) [5,6]. But Umbilical Cord Blood is the most recently identified source of stem cells, appears to be as effective as bone marrow when an HLA-matched adult donor is not available [6,7].

In the past decade, the clinical applications of UCB-based cell therapies have broadened with a growing number of diseases treated with Haematopoietic Stem Cell (HSC) transplantation. Additionally, several investigational human trials involving cell types derived from UCB have been initiated. Umbilical cord is also known as navel string birth cord, funiculus umbilicalis or Wharton's Jelly. Umbilical cord is a rich source of stem cells. Stem cells are the master cells which act as basic building blocks of the body. Currently stem cells are used for the treatment of many diseases (like Neuroblastoma, multiple myeloma, Leukemia, Thalassemia, etc.) through replacement and repair therapies. 1.3 million transplants have been done using stem cells across the globe over fifty years.

Structure of Umbilical Cord

Umbilical cord forms around the fifth week of pregnancy. Umbilical cord is a flexible tube like structure with two layers, an outer layer of smooth muscle and an inner layer containing a gelatinous fluid called Wharton's jelly. Through the abdomen umbilical cord enters into the foetus and turns into two branches, one branch attached with the hepatic portal vein in the liver and other branch connects to the heart through the inferior vena-cava. Umbilical Cord has three vessels; one vein and two arteries (Figure 1). Oxygenated blood and nutrients have been supplied by vein to the foetus and arteries carry deoxygenated and nutrient-depleted blood away from the foetus. Umbilical cord is 20 inch long and S to s inch in diameter. After birth, umbilical cord is cut and the remaining section will heal and form the baby's belly button.

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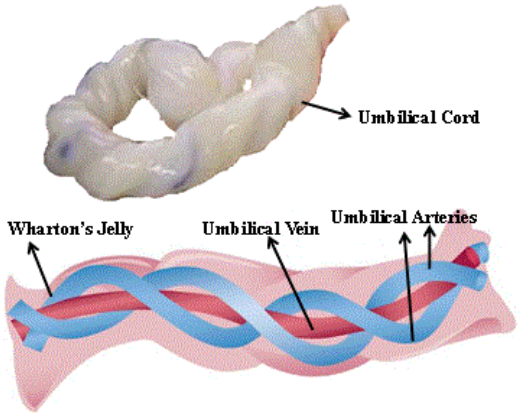

Figure 1. Structure of umbilical cord.

Function of Umbilical Cord

The umbilical cord has three functions first it serves as a blood source for the foetus, foetus is unable to breathe thus umbilical cord allows to obtain oxygen to live the foetus, second is that foetus has no way to intake food umbilical cord serve as a source of nutrients including calories, fat, protein, vitamins as well as nutrients and third is umbilical cord transfers waste products away from the foetus to the maternal circulation, where it can be processed and excreted.

Collection and Preservation of Umbilical Blood Cord and Umbilical Cord

The blood inside the cord is called cord blood and it contains undifferentiated stem cells. Cord blood can be removed from the cord and stored in public or private bank for the use of many medical conditions. The development of successful clinical therapies will likely depend on our ability to acquire functional EPCs from cryopreserved UCB [8]. The collection of umbilical cord is made after delivery and ligation of the cord, prior to expulsion of the placenta. Before the collection of cord blood, the cord is wiped with alcohol or betadine to ensure sterility or contamination of the collection [9]. There are a variety of methods used to collect cord blood, although primarily either large syringes (60 cc) or small bags (approximately 400 cc) are used.

Cord blood is collected just after baby birth. After the birth the cord is clamped and cut by doctor then he/she inserts a needle into the umbilical vein on the part of the cord that still attached to the placenta. Collect this blood into collecting bag and ship this to cord blood bank. Where it is tested, processed and cryopreserved for long term storage in cryo-vials under controlled condition **(Figure 2)**. This process is entirely safe and painless for both mother and child. Before processing of the client has been ensured by the laboratory technologist that the unit belongs to right client or not.

Figure 2. Collection and preservation of umbilical cord blood.

Cord lining will be collected by cutting a segment of baby's Umbilical cord. This cord will be stored in a sterile container provided in Umbilical Cord Collection Kit. These kits meet all regulatory requirements for shipping blood, including double

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containment and a crush-resistant container. The umbilical collected is sent to the laboratory for processing and cryopreservation. All the steps are performed in a biohazard safety cabinet to eliminate the contamination risk. Umbilical cord is cleaned with buffer solution and segmented into small pieces (all other components have been removed except cord lining).

Now decontaminated segments (small pieces of cord lining) are transferred into multiple cryo-vials and added cryoprotectant solution to save the viability of the segments. Once the cryoprotectant solution has been added, the cord lining segments are frozen gradually in the controlled-rate freezer, where the temperature is lowered by 1-2°C per minute to preserve the viability of the stem cell. After that cryo-vials are transferred into liquid nitrogen for long term cryopreservation at -196°C for the further use **(Figure 3)**.

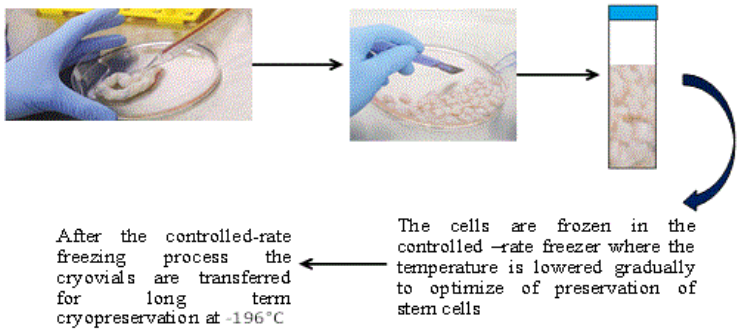

Figure 3. Process of umbilical cord preservation.

Benefit of Umbilical Cord preservation

Umbilical cord blood is used to treat many blood and immunological disorders as well as some cancer. Stem cells found in cord blood are younger; they have proliferative properties and have greater ability to regenerate. Collection process is safe, non-invasive and painless. Contamination risk is very low and teratoma formation risk is nil. Work that was begun in the early 1980s revealed that cord blood (i.e., the leftover blood in the umbilical cord and placenta after the birth of a child) was comparable to bone marrow in terms of its utility in stem cell transplantation [10,11].

The potential for the use of UCB stem cells to regenerate insulin production in juvenile diabetes patients has been reported [12]. Those children's UC has been preserved they are now pioneers in helping to develop effective therapies for juvenile diabetes using one's own stem cells. It can be done only by those whose parents preserved their umbilical cord blood [13]. Cord blood stem cells are primitive and more adaptable it reduces the risk of Graft Versus Host Disease risk (GVHD). Stem cells are able to repair damaged heart and nervous tissues, to treat type 1 Diabetes, to give rise to liver and corneas, to treat children born with neurological defects, and to cure severe combined immunodeficiency disease via gene therapy. In the coming years, there will undoubtedly be additional uses that are not yet anticipated [13,14].

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