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Review

Use of hematopoietic stem cells in obstetrics and gynecology ☆

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Abstract

Stem cells can be used in different areas of obstetrics and gynecology. Adult stem cells are specialized cells found within many tissues of the body where they function in tissue homeostasis and repair. In vitro they have been shown to differentiate into a wide variety of cell types. Hematopoietic stem cells (HSC) have been used to set up therapeutic strategies for the treatment of gynecological solid tumors such as ovarian cancer. Stem cells can be used for prenatal transplantation and in utero gene therapy. Also stem cells can be used in infertility and IVF for research and treatment.

Keywords: Hematopoietic; Stem cells; Obstetrics; Gynecology; Infertility; Gene therapy; Transplantation; Oocyte; Sperm; Gametes; Cancer; Cord blood; IVF

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☆ The hematopoietic stem cells (HSC) are a classical example of adult stem cells. They are able to generate all the cells in blood and immune system. HSC can be used in different areas of obstetrics and gynecology such as cancer, in utero transplantation and infertility.

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1. Introduction

Stem cells are defined as clonogenic, self-renewing progenitor cells that can generate one or more specialized cell types capable of differentiation into several different cells. Stem cells can be classified into two major categories, according to their developmental status: embryonic stem cells and adult stem cells.

Embryonic stem cells are pluripotent cells isolated from the inner cell mass of the blastocyst-stage mammalian embryo [1]. Pluripotent cells are cells capable of giving rise to most tissues of the organism, including the germ line during development. Human embryonic stem cells were first isolated in 1988 and were shown to retain plasticity the same as mouse embryonic stem cells, i.e., the ability to differentiate into several somatic or somatic-like functional cells such as neurons, hepatocytes, cardiomyocytes, and others [2]. The promising nature of embryonic stem cells and their remarkable ability to become any other type of cell have allowed rapid progress toward promising treatments in animal and laboratory experiments. Embryonic stem cell lines, both human and mouse, can be grown indefinitely in vitro if the correct conditions are met.

Adult stem cells are specialized cells found within many tissues of the body where they function in tissue homeostasis and repair. They are precursor cells capable of differentiation into several different cells. They have been isolated from bone marrow, liver, brain, dental pulp, hair follicles, skin, skeletal muscle, adipose tissue, and blood. They have been shown to differentiate into a wide variety of cell types such as osteoblasts, chondrocytes, endothelial cells, skeletal myocytes, glia, neurons, and cardiac myocytes [3].

The hematopoietic stem cells (HSC) are a classical example of adult stem cells. HSC are isolated from the bone marrow, peripheral blood after mobilization with hematopoietic growth factors, and umbilical cord. They are able to generate all the blood types and the immune system. The therapeutic potential of these cells has been fully recognized with the successful use of HSC transplantation for hematological and immune diseases. The intravenous infusion of fresh HSC from a healthy donor, or cryopreserved HSC from the patient itself, allows the hematopoietic and immune reconstitution in patients that have previously received myeloablative doses of chemotherapy and irradiation to eliminate the marrow disorder. This implies extensive self-renewal of the transplanted HSC and their differentiation into every mature blood cell type [4].

HSC are capable of genomic reprogramming upon exposure to a novel environment and give rise to other tissues such as liver, cardiac muscle, or brain. There are also data supporting the hypothesis that hematopoietic tissue harbours mobile subpopulations of non-hematopoietic tissue committed stem cells and more primitive pluripotent stem cells that are released into peripheral blood after tissue injury to regenerate damaged organs [5].

Hematopoietic stem cells can be used in different areas of obstetrics and gynecology [6]. Umbilical cord blood is a precious source of stem cells and it can be used for cell-based treatments of malignancies and inherited diseases. Fetal stem cells from can generate microchimerisms in the mother and contribute to tissue repair mechanisms in different maternal organs. Hematopoietic stem cells have been used to set up therapeutic strategies for the treatment of gynecological solid tumors such as ovarian cancer. Stem cells can be used for prenatal transplantation and in utero gene therapy. Also stem cells can be used in infertility and IVF for research and treatment purposes.

2. Hematopoietic stem cells and gynecologic malignancies

Allogeneic stem cell transplantation for treatment of hematologic malignancies was originally based on the effects of a myeloablative regimen. This procedure was supposed to eradicate the underlying disease after induction treatment. Later, it was found that allogeneic cells were responsible for an immunologic response against the tumor called a graft-versus-leukemia (GVL) effect. Immunologically competent T lymphocytes transplanted with the allograft are responsible for this effect [7]. However, target antigens for GVT activity are not known yet and to what extent the donor T cell population mediates a graft-versus-tumor (GVT) activity and GVHD is still unclear. The procedure is associated with a very high rate of toxicity, including GVHD and infections. Therefore, morbidity and mortality limit its indication for younger patients with good prognosis medical conditions and with minimal residual disease. Recently nonmyeloablative regimens in combination with pre- and post-transplantation immunosuppression have been proposed to reduce toxicity [8]. In this procedure stem cells from either bone marrow or periph-