

UMBILICAL CORD STEM CELLS



Jayanti Tokas¹, Puneet Tokas², Rubina Begum¹, Shailini Jain³ and Hariom Yadav³

¹Department of Biotechnology, JMIT, Radaur, Haryana, India

²KITM, Kurukshetra, Haryana, India

³NIDDK, National Institute of Health, Bethesda, MD 20892, USA

Email: yadavhariom@gmail.com



Umbilical cord stem cells (UCS cells)

- Also Known as Wharton's Jelly
- Adult stem cells of infant origin
- Isolated prior to/ immediately following birth
- Haematopoietic stem cells (Majority)
- 100,000 stem cells per mL in UCB
- Alternate to bone marrow stem cells



Umbilical cord stem cells

Three important functions of UCS cells:

- **Plasticity:** Potential to change into other cell types like nerve cells
- **Homing:** To travel to the site of tissue damage
- **Engraftment:** To unite with other tissues



Cord blood Vs Bone Marrow

Cord Blood

- Collection is non-invasive, painless, and poses no risk to the donor.
- Greater HLA compatibility due to decreased functionality of fetal lymphocytes.
- Graft versus Host Disease (GVHD) is reduced to 10% due to the absence of antibodies in the stem cells.
- Units are processed and ready for transplant.
- Significantly less expensive

Bone Marrow

- Collection is invasive and painful. Must be performed in a hospital surgical setting.
- Due to the maturity of the stem cells, it requires a greater HLA match to perform a transplant.
- Serious GVHD occurs in 60% of all unrelated Bone Marrow transplants
- Bone Marrow is dependent on donor participation.



Applications

- Hematopoietic cell transplantation (HCT) of umbilical cord origin is curative for malignant and nonmalignant diseases like Fanconi's anemia, aplastic anemia, leukemias, metabolic and other congenital disorders.
- HLA mismatch may be better tolerated in the UCBT setting than Bone Marrow Transplantation.



Regenerative medicine in cardiology

- Transplanted UCSC provide benefit in cardiac function recovery after acute myocardial infarction in rats (Kai Hong *et. al.*, 2007)
- Some UCSC express cardiac troponin-T, von Willebrand factor, and smooth muscle actin, indicating regeneration of damaged myocardium by cardiomyocytic, endothelial, and smooth muscle differentiation of UCDS cells in the infarcted myocardium



Ischemic vascular disease

- Buerger's disease - characterized by a combination of acute inflammation and thrombosis (clotting) of the arteries and veins in the hands and feet leading to pain, ulceration and necrosis of extremities
- Umbilical cord blood (UCB)-derived mesenchymal stem cells (MSCs) were transplanted to HLA matched patients
- After transplantation ischemic rest pain disappeared, necrotic skin lesions were healed within 4 weeks.



Metabolic storage diseases

- Hurler syndrome- Severe form of mucopolysaccharidosis type I, causes progressive deterioration of the CNS and death in childhood.
- Transplantation of umbilical cord blood stem cells improved neurocognitive performance and decreased somatic features of Hurler's syndrome



Hemoglobinopathies

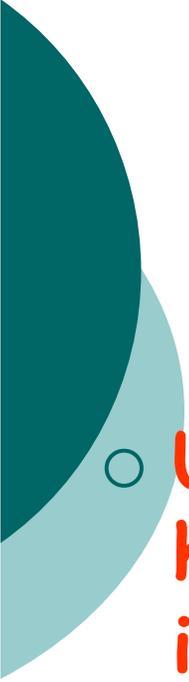
- Fanconi anemia- Umbilical cord blood cells from HLA matched sibling used. The engraftment is slow. There is no graft-versus-host disease.



Malignant diseases

- Acute leukemia- Cord blood from an unrelated donor was found to be useful for adults with acute leukemia who lack an HLA-matched bone marrow donor

(Wall *et. al.*, 2005)



Neurological disorders

- UCMS cells transplanted into the brains of hemiparkinsonian rats that were not immune-suppressed.
- Neural transplantation showed to ameliorate functional and cognitive deficits in animal models of neurological disorders and has reached clinical trials in Parkinson disease, Huntington disease and stroke.



Cellular vehicles for gene therapy

Umbilical cord stem cells can be stably transduced using Retroviral vectors for necessary genetic correction and can be used for transplantation



Future applications

- In autoimmune diseases, where there has been some success with autologous transplantation and the low risk of graft-versus-host disease makes cord blood transplantation attractive.
- In elderly patients with a high risk of graft-versus-host disease
- In theory, in an HIV patient, an allogenic umbilical cord stem cell vaccine may be used to replace the HIV infected hematopoietic stem cells.



Cord Blood banking

Cord blood banking involves

- Recruitment
- Consent
- Testing of maternal donors
- Collection
- Processing
- Cryopreservation
- Testing
- Releasing cord blood unit to transplant centre



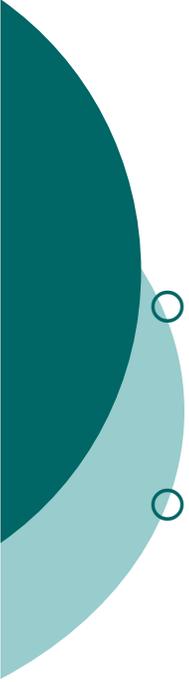
Tests for UCB

- Measurement of Viability (Flowcytometry)
- Blood Typing
- Counting of blood cells
- Count of CD34+ Stem cells
- CFU assay
- Anit-HIV
- CMV
- Anti HBc
- Anti HCV
- HBsAg
- *Ex vivo* expansion



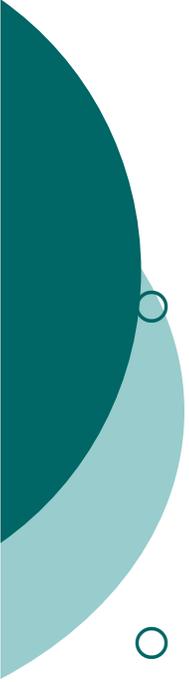
Limitations of cord blood stem cells

- Limitations of cord blood stem cells for allogeneic transplantation
 - Delayed platelet engraftment
 - Delayed neutrophil engraftment
- Limitations of cord blood as a stem cell source
 - Limited amount of source material
 - Same donor not available for repeated dose



Conclusions

- Unlimited source of stem cells from biological waste
- Collection of cord stem cells is painless
- Collection of cord stem cells is risk free to mother and baby
- Cord blood stem cells have a greater ability to differentiate into other cell types
- These cells have longer growth potential and have been shown to have a greater rate of engraftment



Conclusions

- Cord blood stem cells are much more tolerant to HLA tissue mismatching than bone marrow therefore leading to lower rate of GVHD
- Cord stem cells are not exposed to the toxins and radiations (we experience in everyday life)
- Cord blood stem cells are being used in the treatment of 40 medical conditions with over 72 potential disease targets
- Research should be oriented towards prolonging their storage and enhancing their expansion

A close-up photograph of a hand holding a vibrant yellow daffodil flower. The background is softly blurred, showing a person's face. Overlaid on the right side of the image is the text 'THANK YOU' in a playful, rounded font. Each letter is filled with a different color from the rainbow spectrum, creating a vibrant and cheerful message.

THANK
YOU