The sky is the limit: Potential clinical uses of umbilical cord blood stem cells and Wharton's jelly mesenchymal stem cells

Omar Aljitawi, MD
Blood and Marrow Transplant Program
Pathology and Laboratory Medicine
University of Kansas Medical Center, Kansas City, KS

First successful cord blood transplant (1988)

Umbilical cord blood extraction

- A major collaborative effort across the Atlantic:
  - A patient of Dr. Joanne Kurtzberg
  - The cord blood was banked by Dr. Hal Broxmeyer
  - Dr. Elaine Gluckman performed cord blood transplant in Paris

*Since the first successful UCB has been used as a graft source for over 25 000 patients with both malignant and non-malignant diseases (Cutler et al, 2012).

Umbilical cord blood transplantation at KUMC

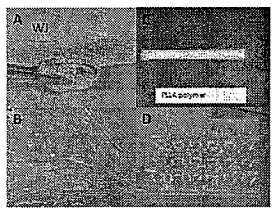
- KUMC has been involved in umbilical cord blood transplant clinical trials, including Clinical trial network (CTN) trials #0604 and CTN #1101
- KUMC has been involved in pre-clinical experiments expanding umbilical cord blood stem cells

Ex vivo expansion of umbilical cord blood stem cells

A Wharton's Jelly Mesenchymal Stromal Cell Derived 3D Osteogenic Niche (Bone) Allows for Cord Blood Stem Cell Expansion

Components of the 3D structure used to expand UCB stem cells

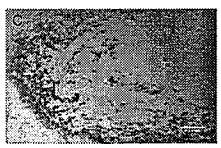
- Occupying cells: mesenchymal stromal cells isolated from umbilical cord Wharton's jelly matrix (A and B)
- Synthetic scaffolds(PLLA) to provide the 3D frame (C and D)



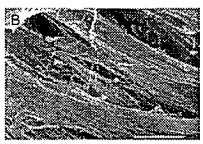
Cells positive for CD 90, CD105, CD 73 and negative for CD 34, CD 45, and isotype consistent with MSC phenotype

Verification of Osteogenic (bone) differentiation

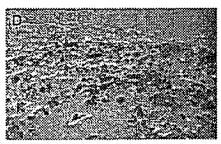
Scanning electron microscopy pictures



Alizarin red staining

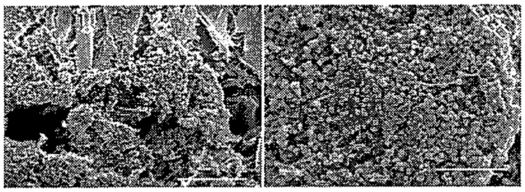


Bone producing cells and matrix



Bone mineralization

Expansion of umbilical cord blood stem cells



Umbilical cord blood stem cells attached to bone producing cells

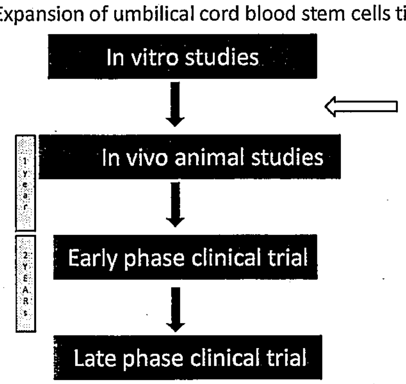
Indications for umbilical cord blood transplantation

Table 3
Numbers of hematopoietic stem cell transplants in Europe 2008 by main indication and use of related and unrelated CB products. Numbers refer to patients with first HSCT only; BM, Bone Marrow; CB, Cord Blood; PB, Peripheral Blood. Proportion: Percentage of CB as stem cell source amongst allogeneic HSCT.

Main indication	Family		Unrelated		Total	Proportion	Autologous		Total	
	BM/PBSC	CB	BM/PBSC	CB	Allo	CB Allo	BM/PBSC	CB	BM/PBSC	CB
Leukemias	3514	11	3413	456	7394	6.3	938	0	7865	467
Acute	2584	8	2262	337	5191	6.8	810	0	5656	345
Chronic	930	3	1151	119	2203	5.5	126	0	2207	122
Lymphoproliferative disorders	853	0	728	32	1636	3.2	12,900	0	14,493	32
Solid tumors	46	0	14	1	61	1.6	1400	0	1460	1
Non-malignant disorders	822	96	319	115	1252	11.7	168	0	1309	151
Bone marrow failures	380	9	176	34	598	7.2	2	0	558	43
Congenital disorders	440	28	138	80	684	15.5	7	0	585	108
Auto immune disease	2	1	5	1	9	22.2	198	0	196	2
Others	51	1	28	18	76	38.7	25	0	88	19
Total	5270	48	4502	609	10,450	5.6	15,437	0	25,209	657

A. Gratwohl, H. Baldomero / Transfusion and Apheresis Science 42 (2010) 265–275

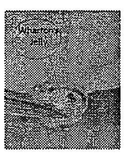
Expansion of umbilical cord blood stem cells timeline



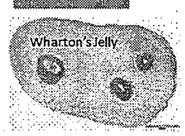
Wharton's jelly mesenchymal stem cells

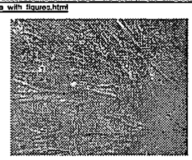
- KU and KUMC researchers have been involved in Wharton's jelly mesenchymal stem cell research for cancer and various regenerative applications

Umbilical cord's Wharton's Jelly mesenchymal stem cells



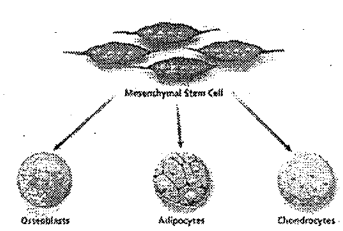
http://acad.rosalindfranklin.edu/cms/anatomy/histohome/lectures/ct2/ct_2_lecture_with_figures.html





Wharton's Jelly mesenchymal stem cells

Mesenchymal stem cells



www.sigmaaldrich.com/life-science/stem-cell-b...

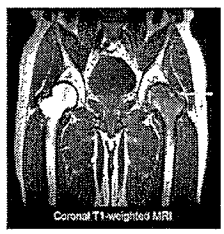
Wharton's jelly mesenchymal stem cells undergoing osteogenic differentiation (Bone differentiation)

Wharton's jelly mesenchymal stem cells...Potential applications

Cartilage and bone regenerative purposes

- Joints
- non-healing fractures
- Bone defects secondary to tumors or trauma

Hip bone avascular necrosis



3 dimensional cancer models for personalized medicine

Umbilical cord blood/umbilical cord tissues represent green investment in future