Investigation of bone marrow mesenchymal stem cell properties in patients with beta thalassemia major: FTIR spectroscopy and imaging study

Ceren Aksoy[1], Duygu Uçkan Çetinkaya[2], Feride Severcan[2]*

[1] Department of Biotechnology, Middle East Technical University, Ankara 06531, Turkey
[2] Division of Pediatric Hematology, Hacettepe University, Ankara, Turkey
[2*]Department of Biological Sciences, Middle East Technical University, Ankara 06531, Turkey

Mesenchymal stem cells which are defined by their multidifferentiation potential are the main cellular components of the bone marrow heamatopoietic stem cell (HSC) niche. It has been recently shown that the bone marrow niche with stromal mesenchymal stem cells (MSCs) is very important for maintenance of healthy heamatopoiesis, because mesenchymal stromal cells provide a supportive cellular microenvironment for regulation of self renewal versus differentiation of heamatopoietic precursor cells (HPCs). A balance for healthy heamatopoiesis is mediated by direct cell-to-cell contact between MSCs and HSCs and by interactions between HPCs and cytokines and also extracellular matrix components. β-thalassemia major (TM) is characterized by anemia which is caused by a genetic defect in hemoglobin synthesis and results in ineffective erytropoiesis (IE). The alterations in the microenvironment and stromal defects in thalassemic BM during IE can cause changes in MSCs. This study aimed to investigate global structural and compositional changes in BM-MSCs in β-thalassemia major that may provide basis in understanding in MSCs and the specific HSC-MSC interactions in such a pathological BM microenvironment. After morphologic, immunophenotipic and differentiation properties were characterized, the changes in healthy and thalassemic MSCs before and after bone marrow transplantation (BMT) was examined by FTIR spectroscopy and imaging studies. FTIR spectroscopy results showed significant increase in lipid, protein, glycogen and nucleic acid contents in thalassemic MSCs with respect to healthy MSCs was attributed to enhanced cell proliferation and BM activity during IE. However, the increases in the content of mentioned macromolecules were significantly higher in the pre-transplant MSCs than post-transplant group MSCs that was interpreted as restoring effect of BMT therapy on IE and defective BM microenvironment. These alterations that interpreted as an increased in cellular activity were also supported MTT proliferation assay of thalassemic and healthy MSCs. Based on these changes sampling groups were discriminated by cluster analysis. This study was also corroborated with FTIR imaging study in order to obtain detailed comparative analysis of the sampling groups's by chemical maps of the samples that were obtained by taking integrated area ratios of the different vibrational modes. These results can provide supportive information for the studies that concenrate on explanation of interactions between HSC-MSC in BM.