Ultrastructure differences during in vitro osteogenesis and chondrogenesis of bone marrow mesenchymal stem cells

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Musculoskeletal diseases with osteochondrotic articular cartilage defects such as osteoarthritis, are an increasing problem for humans and the development of novel and improved therapeutic strategies is necessary.

Adult mesenchymal stem cells (MSCs) are multipotent cells with the potential to generate variouos tissues such as bone, cartilage, muscle, bone marrow stroma, tendon/ligament, fat, dermis and other connective tissues under appropriate biochemical, mechanical and hormonal stimuli For this capacity MSCs represent a promising model for tissue engineering and regenerative medicine.

Although MSCs are well known for their molecular phenotype markers, a few analysis have been undertaken to characterize their ultrastructure. The study of morphology, 3D structure, cytoplasmic projections and contacts among cells could represent an important point to understand the interaction of MSCs in tissues and with a specific substrate such as a 3D scaffold.

The main purpose of this paper is to describe the morphological modifications of MSCs in vitro differentiated to osteogenic and chondrogenic phenotype and to focus on the ultrastructural details specifically connected with the differentiation process.

Bone marrow MSCs were isolated, expanded in vitro and stimulated with osteogenic and chondrogenic factors for 24 h, 7, 14, 21 and 28 days. At the different experimental times, cells were detached from the flasks and processed for high resolution scanning electron microscopic analysis (FEISEM).

After 24 h MSCs appeared round shape with the surface covered by several ondulopodia, and filopodia, which allow them to adhere to the substrate. During the differentiation, MSCs changed their shape from a round to a fibroblastic like one, and several filaments of different diameters with a parallel orientation in osteogenic samples as well as a network orientation in chondrogenic samples, were detected in the intracellular spaces.

This study demonstrated that there are some morphological differences in MSCs differentiated to different phenotypes and these ultrastructural features could be utilized as morphological parameters for an in vivo identification and classifications of MSCs useful for their use in regenerative medicine.

Key words
Mesenchymal stem cells, ultrastructure, osteogenesis, chondrogenesis, FEISEM