Biological Effects and Risks of Nano-bioceramics

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The progress of nano-technology is opening up a new path for the development of biomaterials. From material's standpoint, biological tissue can be considered as a composite consisting of nano-biomaterials, for example, nano-muscle fibers, nano-apatite grains, nano-membrane, et al. The highly structural imperfection of nano-biomaterials endows the materials with high activities, thus, lead to unexpected biological effects, including positive effects and biological risks.

This presentation was focused on the biological effects of bioceramics with nano-structure and nano-ceramic particles, and showed that the calcium phosphate (Ca-P) bioceramics consisted of nano-scale grains had higher absorbing capacity selectively for proteins with low molecular weight, i.e., growth factors in vivo, and could initiate a higher expression level of osteogenic genes in cells, thus appeared excellent osteoinductivity, in comparison with common Ca-P ceramics with micro-scale grains. The bioinert ceramics and metals could also be bioactive if the crystal grain in the materials reached a nano-scale or their surface / interface had a nano-structure. The nano-structure of bioceramics could greatly promote their bioactivities.

It is a general consideration that biological risks of nano-biomaterials are mainly from their effects on cell apoptosis, which is led by the nano-particles penetrated cell membranes and entered into nucleus. Bioceramics, consisted nano-crystal grain could be biodegraded and produced nano-particles in vivo, thus have the potential biological risks. Recent studies have shown that the effects of nano-biomaterials on cell apoptosis were selective for cells; and they were not only concerned with the size of nano-particles, but also with chemical composition of the particles. The nano-hydroxyapatite (HA) particles from the biodegradation of HA ceramics could penetrate the membranes of tumor cells and enter the nuclei, thus lead to tumor cell apoptosis, but the apoptosis of normal fibroblasts led by nano-HA particles was not obvious. It was also found that the effects of nano-TiO2 particles to tumor cell apoptosis were weaker than that of nano-HA particles. The results meant that a suitable nano-bioceramics or bioceramics with nano-structure may have the function to treat diseases besides repairing tissue defects.

From the discussions mentioned above, it is known that nano-bioceramics have the potential to present unexpected excellent biological functions, which are awaited to explore further, and at the same time, the biological risks of nano-effects must be studied deeper. It has been found that the nano-HA particles could down-regulate the expression of some cancerogenic genes in tumor cells, but a few cancerogenic genes were up-regulated. In any case, nano-technology and nano-biomaterials show a great potential in biomaterial areas.