

In vivo estimation of nanotoxicity of nanomaterials for orthopedic implants

ABSTRACT

Nanotechnology is the first major worldwide research initiative of the 21st century. Nanotechnologies are general purpose technologies that act as both the basis for technology solutions across a range of industrial problems or as a nexus for the convergence of other enabling technologies like biotechnologies, computational sciences, physical sciences, communication technologies, cognitive sciences, social psychology and other social sciences. However, there is currently great concern that engineered nanoparticles may exert unexpected toxicities and pose a threat to human health and the environment. On the other hand, nanoparticles may be exploited for targeted drug delivery and could reduce the adverse bystander effects of conventional drugs, including chemotherapeutic drugs. This thesis' goal is to determine factors that have crucial role in the appearance of toxicity effects in living organisms due to the use of nanomaterials. In the first part it is mostly provided a great piece of information that concern the categorization of nanomaterials as well as the possible ways of nanomaterials' entrance in human organism and the understanding of all the physicochemical parameters that toxic effects depend on. We discuss matters of histopathology and we analyse the structure and defects of the articulate cartilage . Then we search bibliography data about animal testing and especially in sheep and goats and we design the research scheme. In the second part we present the design of the prosthesis, the development and the characterisation of the biodegradable polymeric scaffold, the technique of protein engineering for the synthesis of the bioactive molecules and their fixation on the surface of the implants so as to achieve the mesenchymal cells' differentiation to chondrocytes and their attachment in that specific area of the arthrosis. We manage to isolate mesenchymal cells from adipose tissue of the animals and to proliferate them and place them on the head of the biofunctionalized implants. The last part describes the surgical implantation of the so called Complete Implants in the inner medial condyle of the goats and their postsurgical treatment and survival through the time till they were euthanized and an autopsy was performed. When their knee joint was dissected there was a newly created tissue on the head of the implants which in the histologic sections that were performed proved to be hyaline cartilage, that is articulate cartilage. At no point during that research there was any sign of toxicity of any kind which points out the safety of these procedures. Concluding there is a discussion of the results and suggestions for future research.