Editorial

Nanotechnology: A double-edged sword

Debilitating diseases are playing havoc in many lives worldwide. Unfortunately, this is related to delay in the diagnosis and treatment plan which leads to the further progression of disease and reduced survival of the patients. With the need of advancement in the various diagnostic and treatment aids, it becomes necessary for the mankind to reach the threshold of new era in the cancer, its diagnostic and treatment.

Considering necessity as the mother of invention, nanotechnology is nowadays considered as a fast expanding area of research, yielding many surprises and fostering many hopes, as anticipated in the development of novel, sophisticated, applications which readily recognizes the diseases, deliver drug to the target tissues, report outcome of the therapy and monitor intracellular changes.[1]

We all know that the impact of the object is not dependent on the size of the article. Even smaller particles can cause large disaster. Nanotechnology is derived from Greek word 'nanos', which means dwarf. It was first projected by physicist Richard P Feynman, in his speech to the American Physical Society. The term nanotechnology was next introduced by Norio Taniguchi in 1974. Nanotechnology, when used in dentistry, is called nanodentistry. Nanodentistry will make the maintenance of near-perfect oral health possible by the use of nanomaterials, biotechnology and nanorobotics.[2]

Nanotechnology can be used in fields of dentistry like restoration of sensation after application of local anesthesia, bone replacement therapy, directing periodontal ligament for painless tooth movement, cure of hypersensitivity, tooth replacement therapy, drug delivery to the targeted organ and killing of cancer cells; nanorobots can be helpful in making orthodontic movements and nanofillers incorporation into impression making material can be helpful in improving hydrophilic properties of the material, early detection of oral cancer, early detection of prostate and lung cancer.[3]

Although nanotechnology appears to introduce ground-breaking techniques and devices in the dental field, there are some concerns as well. This includes economical nanorobots mass production technique, ethical issues, biocompatibility and human safety.

There is a saying that 'All good fruits will turn bad'. As there is reduction in the size of nano-sized particles, it will result in an increase in particle surface area, chemical molecules may get attach to this particle surface, which would result in enhancement of its reactivity and result would be increase in toxic effects. The reason for this is smallest particles have more pathological and destructive power on the human body rather than the same particles of smaller size because they have their larger surface area, greater tendency to conjugate with each other and energy sustainability within them self. High dose of nanoparticles (small or big) could be harmful to health as they can cause formation of reactive oxidative stress in the body, which gives rise to inflammation, cell destruction and genotoxicity by activating the redox cycle.[4]

Nanoparticles may be of the same dimensions as some biological molecules such as proteins and nucleic acids. Human body is affected by the nanoparticles through nanoparticle cycle. Through this cycle, the nanoparticles get circulated in the atmosphere and affect the human body and the nature. All nanoparticles, on exposure to tissues and fluids of the body, will immediately adsorb onto their surface. Nanomaterials can enter into the blood stream after their inhalation (Oberdörster et al, 2005) or ingestion (Hoet et al, 2004). Once in the blood stream, nanomaterials can be transported around the body and are taken up by organs and tissues and adversely affect them.[4]

Various studies have been conducted and some are in progress in relation to the nanotoxicology. On the basis of the study, various conclusions have been drawn which states that nanoparticles in sunscreen cause DNA damage in skin cell, nanotubes are toxic on prolong use, gold nanoparticles can move along placenta from mother to fetus, they cause toxic effect on macrophages, epithelial cells, fibroblasts and mitochondria.[5]

Various steps should be taken to reduce the toxicity of the nanoparticles. Some of them have been mentioned below:[6]

1. Use large size nanoparticles of size 300 nm.
2. Demonstration on three-dimensional before clinical trials.
3. Develop models *in vivo* and *in vitro* for interaction with human body to assess toxicity.
4. Ban the use of untested nanoparticles.
5. Nanoparticles used in sunscreen should be put to check by GRAS (Generally recognized as safe).
6. Increase intake of antioxidants, vitamins, fresh fruits and vegetables.

7. Metal chelators to reduce the toxicity caused by metal nanoparticles.
8. Use of sodium cromoglycate to reduce airway inflammation caused by nanoparticles.

Thus, the future of nanotechnology remains exciting and wide open for ongoing efforts by scientists and researchers who can ensure to do great things by using the small ones. But due to the growing concern on the unseen human and environmental hazard, it is recommended that *in vitro* and *in vivo* toxicity screening tests should be done on all the nanoparticles before their use in market.

References

1. Amiji MM. Nanotechnology for cancer therapy. London: CRC press, Taylor and Francis Group. p. 3-5.
2. Sivaramakrishnan SM, Neelakantan P. Nanotechnology in dentistry: What does the future hold in store? Dentistry 2014;4:198.
3. Bhavikatti SH, Bhardwaj S, Prabhuji ML. Current applications of nanotechnology in dentistry: A review. Gen Dent 2014 Jul-Aug;62(4):72-77.
4. Patni S, Bhatia AL. Nanotechnology: A double edged sword. Asian J Exp Sci 2008;22(2):153-166.
5. Ai J, Biazar E, Jafarpour M, Montazeri M, Majdi A, Aminifard S, Zafari M, Akbari HR, Rad HG. Nanotoxicology and nanoparticle safety in biomedical designs. Int J Nanomedicine 2011;6:1117-1127.
6. Buzea C, Pacheco II, Robbie K. Nanomaterials and nanoparticles: Sources and toxicity. Biointerphases 2007 Dec;2(4):MR17-71.

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