Minireview Article

NANO ANESTHESIA AND NANO DRUG DELIVERY- A REVIEW ARTICLE

ABSTRACT:

Nano Technology is phenomenon present since the late 1950's and is currently finding strong grounds in the field of dentistry. Nano Technology is based on concept of creating functional structure by controlling atoms and molecules on a one by one basis. The advents of nano technology involve the application of nano robots in various aspects of dentistry like local anesthesia, dentition, re-naturalization and permanent hypersensitivity cure. Nano drug delivery systemsprovide a new drug delivery method for treatment of various dental aliments. Nano material also appeals to researchers in the areas of cancer diagnosis and bio- marker discovery. The current review presents an updated summary of recent advances in the field of Nano Dentistry in the form of nano drug delivery systems and nano anesthesia, thus improving both the efficacy of novel and old drugs.

Keywords:Nano Dentistry, Nano anesthesia, Nano drug delivery, Nano technology.

INTRODUCTION:

Theword "Nano" is derived from greek word for "dwarf". Nano represents one billionth of any unit of measure.[1] It means that, one "nanometer" equals to 2–3 atoms or one millionth of a meter (10−9 meters.[2,3] Nano Technology, a field of science that includes research and development of the manipulation and manufacture of materials and devices measured on the nanometer scale.[4] Nano Dentistry is one of the upcoming topic in Dentistry which may be defined as the improvement and maintenance of oral health through the use of nano materials and biotechnology, including tissue engineering and nano robotics[5]Nano Dentistry includes many things such as Nano composites, Nano robotic dentifrice, Nano impression, Nano solutions, Nano encapsulation,Nano adhesives, Nano diagnostics, Nano anesthesia and Nano drug delivery system, etc. Currently, the field of Dentistry is using nano particles for implantation, drug delivery for caries treatmentand preventative care.[6] Nano materials show better performances than the conventional standard materials in terms of increased stiffness, toughness, transparency, resistance to heat, solvent and abrasion.[7]The present review was conducted to understand Nano anesthesia and Nano drug delivery system in the field of Dentistry.

MATERIALS AND METHODS:

The present review of literature search was done using online and offline mode. EBSCO, Google scholar databases were used. Available journals were checked. The keywords used for the search were "Nano dentistry", "Nano anesthesia", "Nano drug delivery", "Nano technology" etc.The only literature from English language was selected. No patient was involved in the present review. All articles were read thoroughly by all the author's with the objective to understand Nano anesthesia and Nano drug delivery system in the field of Dentistry and then it was summarized.

NANO ANESTHESIA:

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Anesthetic injections are commonly used in dental procedures and can cause discomfort and many associated complications, especially in pediatric patients. The use of nanotechnology in anesthesia includes delivery of an analgesic colloidal suspension containing many functional micron-sized dental nanorobot particles into the patient's gingival mucosa. Upon contact with the gingival mucosa, the mobile nanorobots migrate through the gingival sulcus, pass painlessly through the lamina propria or the layer of loose tissue on the cemento-dentinal junction, and enter into the pulp where they control nerve impulses by blocking the nerve endings Upon completion of dental treatment, the dentist stimulates the nanorobots to restore all nerve impulses and leave the tooth in a similar manner. This is followed by aspiration of the tooth. Nanorobotic analgesics offer greater patient comfort, precise selectivity of analgesic effect, less side effects and complications, minimal patient anxiety and controllability and complete reversibility of the analgesic effect.[1] Nano anesthesia is a bottom up approach. According to Das et al., 2007, the bottom up approach seeks to arrange smaller components into more complex assemblies, the covalent bonds of which are extremely strong.[6]

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Possible advances of Nanotechnology in Anesthesia:

Nano Local Anesthesia- Lidocaine-loaded poly (carpo-lactone)-poly (ethylene glycol)-poly (carpo-lactone) (PCL-PEG-PCL) Nano particles in hydrogel was prepared of size 200 nm. This has been shown to be superior in terms of onset of anesthesia and efficacy. Once drug is injected, it is directed through Nano-computer to the specific site where action is required. It is kept at that site for wanted time and removed from body when not required.[7]

Nano General Anaesthesia- At Canary Islands, Automatic controlled anesthesia system was developed which detects hypnotic state based on EEG & BIS and supplies appropriate dose of anesthetic. It is a computer software program which saves time, an aesthetic drug and their doses. Examples include Nano formulated drugs like anesthetic drugs and diclofenac, Biosensor for monitoring depth of anesthesia, Nanotube capnograph sensor, Real time non invasive glucose and electrolyte monitoring.[7]

Comment [ar6]: Anesthesia

Nano Regional Anaesthesia- With nanotechnology, an antidote to bupivacaine overdose is possible. There is a formation of pi-pi complexes between bupivacaine and a pi-electron-rich injectable nanoparticle. This complex would be devoid of clinical effects of bupivacaine and would thus render toxic bupivacaine harmless. So, it could be possible to counteract high spinal as soon as it is realised.[7]

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Nano needles- It is the top down approach, it seeks to produce smaller devices by using larger ones in achieving precision in structure and assembly.[8] Suture needles with nano sized stainless steel crystals have been developed. The characteristics in general can be said to be a combination of properties of ordinary austenitic stainless and low alloyed ferritic steels. This means that properties such as modulus of elasticity, mechanical properties and thermal expansion are comparable to ferritic steels (such as low alloyed carbon steels or chromium steels) while properties such as corrosion resistance is more comparable to austenitic stainless steels.[8]

NANO DRUG DELIVERY:

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Conventional drug preparations like solution, suspension or emulsion suffer from certain limitations like high dose and low availability, first pass effect, intolerance, instability, and they exhibit fluctuations in plasma drug levels and do not provide sustained effect, therefore there is a need for some novel carriers which could meet ideal requirement of drug delivery system.[10] The nanoparticle-based drug delivery system can overcome many of the disadvantages that conventional drug delivery systems face. For instance, chemotherapeutic agents used in cancer treatment are traditionally distributed non-

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specifically, harming both healthy cells and cancer cells, resulting in low effectiveness and high toxicities. Nanoparticle-based Drug delivery systems would be excellent carriers for chemotherapeutic agents, guiding the chemotherapeutic agents to the tumor site thus increasing the drug concentration in cancer cells and averting toxicity in normal cells.[11] Nanoparticle-based Drug delivery systems can also be used as a prevention method for multiple diseases of the mouth, including the treatment of oral cancer and gingivitis, bone replacement, stem cell imaging, and tracking are among others.[4]

Currently, the medical field is using Nano particle technology as a therapeutic treatment for drug delivery on a cellular level. Nanoparticlesare a type of colloidal drug delivery system comprising particles with a size range from 10 to 1000 nm in diameter. Mesoporous silica nano particles (MSN) shows a great potential in the process of drug delivery. The basic structure of MSN consists of silica precursor, a surfactant, and a catalyst.The mesopores can be loaded with different drugs, DNA, RNA, proteins, dyes, and metal nano particles.[4]

MSN have been loaded with anti-cancer, anti- inflammatory, antibacterial, antidepressant, osteogenic, antioxidant, and hypoglycemic drugs. These include ibuprofen (anti-inflammatory),erythromycin (antibiotic), doxorubicin (chemotherapy),and many more. The primary goals for research of nano-bio-technologies in drug delivery includes:More specific drug targeting and delivery,Reduction in toxicity while maintaining therapeutic effects, greater safety, biocompatibility, andFaster development of new safe medicines.[12] One of the major difficulty in current medicine is the effective delivery system. This can be overruled by the use of appropriate nano delivery systems which are as follows:

***Nano-Capsules*-**One of the major breakthroughs in the branch of dental science is the availability of the nano-capsules. Nano-capsules have been implicated in the providence of drugs by forming a shell like structure. Moreover, the nano capsules can be controlled to be released at a specific location at a controlled rate.[13]

***Nano-scaffolds*-**Utility of nano-scaffold was first administered for the thrust of hormone delivery. However, the usage can be extended to target any specific location in the body for effective delivery of any drug. In dental medicine, uses includes regeneration of various tissues in the oral cavity including PDL and alveolar bone.[9]

***Nano-Quantum Dots*-** Quantum dots would be the most innovative and efficient method for the detection of oral carcinoma. Once the coated quantum dots with special substances are delivered, they will attach themselves to cancer specific cells and effuses ultra-violet spectrum. The light which is emitted has a different wavelength which is altered by the crystal size.[14]

Nano drug delivery can be used in the following:

Hypersensitivity Cure:Dental nano robots could selectively and precisely occlude selected tubules in minutes using naïve biological materials, offering patients quick and permanent relief.[15]Forhypersensitivity caused by the changes in pressure transmitted hydro-dynamically to the pulp.[6]Natural hypersensitive teeth have eight times higher surface density of dentinal tubules and diameterwith twice as larger than nano sensitive teeth.[7]Reconstructive dental robots using native biological materials could selectively and precisely occludespecific tubules within minutes, offering a quick andpermanent cure.[7]An in-vitro study performed with a toothpaste containing nano sized carbonate apatite showed that dentin tubules were effectively sealed, which is important for sustained treatment of dentin sensitivity.[2]

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Treatment of oral cancer: Nanotechnology in field of cancer therapeutics has offered highly specific tools in the form of multifunctional dendrimers and nanoshells. The distinctive property of dendrimers, like their high degree of branching, multivalence, globular structure and well-defined molecular weight make them promising in cancer therapeutics. Nanoshells are miniscule beads with metallic outer layers designed to produce intense heat by absorbing specific wavelengths of radiations that can be used for selective destruction of cancer cells leaving aside intact and adjacent normal cells.[7] Nano materials for brachytherapy, drug delivery across the blood-brain barrier is more effective treatment for braintumours in development. Nano vectors for gene therapy Non-viral gene delivery systems.[16]

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Periodontal diseases:The various nano particles that are being employed for drug delivery in the management of periodontal diseases include nano spheres, nano capsules, nano fibres, nano gels, nano composites, dendrimers and liposomes.[3] Researchers have attempted to generate an effective and satisfactory drug delivery system for thetreatment of periodontal diseases by producing nano particles impregnated with triclosan. It wasconcluded that the application of triclosan particles into the test area alleviated inflammation.[7]Although this study investigated only periodontal therapy, it indicated that targeted drug delivery withnano materials is possible for other treatments. The best example of the future use of this technologyis a procedure called Arestin, in which microspheres containing tetracycline are placed into periodontalpockets and tetracycline is administered locally.[7]

Dentifrobots:Nano robotic dentifrice (dentifrobots) delivered by mouthwash or dentifrice patrol all supragingival and sub gingival surfaces minimum once a day metabolizing trapped organic matter into harmless andodourless vapours, performing continuous calculus debridement and identifying and destroying pathogenic bacteria residing in the plaque and elsewhere, while allowing the 500 species of harmlessoral microflora to flourish in a healthy ecosystem.[6]

Advantages of Nano anesthesia and Nano drug delivery:

It includes controlled release characteristics, enhanced stability and dissolution in aqueous medium, increased transportation across the cell membrane which reduces clearance and enhances bioavailability, improved drug loading ability due to increased surface area per unit mass and higher surface reactivity, size simulating and biomimicking natural tissue and thus better tissue tolerance.[3] Nano anesthesia offers greater patient comfort, reduces anxiety, no needles, greater selectivity, controllability of analgesic effect; fast and completely reversible action; avoidance of side effects and complications.[17]

Disadvantages of Nano anesthesia and Nano drug delivery:

It includes high cost, complicated fabrication, toxicity, practical implementation and uncontrolled self replicating nanorobots will consume earthly resource.[13] Nanotechnology may not be flawless. “The smaller the particles, the more toxic they become,” tests have shown that nanotechnology can function as venom to the communities we live in and nano particles are known to bio-magnify in animal organs. Scientists are also concerned about soil and plant life. Nano particles can cause lung injuries. By balancing its risk and benefit, we can maximize applications in medicine without harming the public health and environment.[16]

Challenges Faced by Nano dentistry:

It requires proper assembling of the molecules to build a functional unit, requires financial constraints for mass production of nano robots, biocompatibility, difficulty in coordinating the activities of nano sized nano robots, public acceptance is questionable, ethics and regulations have to be formulated, human safety issues, etc. due to this it requires further research.[16]

Conclusion:

Nanotechnology is a relatively new, rapidly developing area of science that has great potential in the effective development of new devices and nanomaterials that can be used in the management of human health. This also includes the field of dentistry, where nanotechnology is already being applied for the development of novel nanomaterials, better diagnostic and treatment plans, and tissue regeneration for the improvement and maintenance of oral health. However, despite rapid developments in this field, it is still in its initial phase and, therefore, requires further research and clinical studies.

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