REVIEW

NANODENTISTRY – THE FUTURE AHEAD

SINGLA GORAV [1] VASUDEVA KAMLESH[2] PURI NIDHI[3]

[1](PG Student)
[2](Prof. & Head)
[3](Asso. Prof.)
Department of Prosthodontics,
Govt. Dental College & Hospital, Patiala

ABSTRACT

Dentistry has seen many eras of revolution in past, making it more reliable and comfortable for the patients. It is undergoing yet another change in helping mankind, this time with the help of nanotechnology combined with nanomaterials, biotechnology, and nanorobotics. Nanodentistry will make possible the maintenance of comprehensive oral health by employing nanotissue devices which will allow precise controlled oral analgesia, dentine replacement therapy, permanent hypersensitivity cure, complete orthodontic realignment etc. all in a single office visit.

Key words: nanotechnology, nanorobots, nanodentistry

Address for Correspondence:
SINGLA GORAV
(PG Student)
Department of Prosthodontics,
Govt. Dental College & Hospital, Patiala

INTRODUCTION:

The word 'nano' is derived from the greek word for dwarf. The prefix 'nano' means ten to the minus ninth power 10^{-9}, or one billionth and is usually combined with a noun to form words such as nanometer, nanotechnology, nanorobot etc.

The term 'nanotechnology' was coined by Prof. kerie E. Drexler[1]. Robert A. Freitas defines nanodentistry as ' the science and technology that will make possible the maintenance of comprehensive oral health by employing use of nanomaterials, biotechnology including tissue engineering and ultimately dental nanorobotics'. A nanorobot can be defined as 'an artificially fabricated object able to freely diffuse in the human body and interact with specific cell at the molecular level by itself will have a diameter of about 0.5 to 3 microns. According to the pioneers of nanotechnology, nanorobots will be constructed in next 10-30 years[1]. This type of tiny science was first time revolutionized by Richard Feynman at his famous talk in 1959 entitled 'There is plenty of room at the bottom'. He proposed machine tools to make smaller machine tools, which in turn would be used to make still smaller machine tools and so on all the way down to the molecular levels. Nanotechnology aims to manipulate and control particle to create novel structures with unique properties and promises advances in medicine and dentistry.

Application of nanotechnology in dentistry:

1. NANOMATERIALS

A. Composites with nanofillers/ nanocomposites: nanocomposites have two types of nanofillers – nanomeric type and nanocluster type[4,6,7].

ADVANTAGES:

- High filler loading
- Desirable handling characteristics
- Superior physical properties like modulus of elasticity, flexural strength etc.

High polish retention because of nano size fillers which even if get plucked away by tooth brush abrasion, leave the surface with defects smaller than the wavelength of light.

- Higher translucency giving it more lifelike appearance
- 50% reduction in curing shrinkage

B. Nanoadhesives: they are nanosolutions which produce unique and dispersible nanoparticles which prevent agglomeration[6,7].

ADVANTAGES:

- Higher dentine and enamel bond strength
- High stress absorption
- Longer shelf life
- Durable marginal seal
- No separate etching required
- Fluoride release

C. Nanoimpression material:

impression materials are available with nanofillers integrated in the vinylpolysiloxane producing a unique addition siloxane impression material[6,7].

ADVANTAGES:

- Better flow
- Improved hydrophilic properties and

hence fewer voids at margin and better model pouring.

- Enhanced dental precision

D. Dentifrices: using nanosized hydroxyapetite crystals, dentifrices are manufactured which form a protective layer on tooth enamel, and even restore the surfaces in damaged areas. Dentifrices like Microbrite has been

microhydrin which consists of molecular cages, 1-5 nanometer in diameter and degenerate the organic food particles[5].

E. Materials to induce bone growth: Calcium sulfate is used to fill small voids such as those found in post-extraction sockets and periodontal bone defects and as an adjunct to the longer lasting bone graft materials. Dr Ricci has formulated a new calcium sulfate based nanocomposite, Bone Gen-TR which resorbs more slowly and regenerates bone more consistently[3].

F. Materials to induce radiopacity: Bismuth oxide has been used for years to impart radiopacity to the materials and instruments. But as instruments and materials are getting smaller and smaller, it is very difficult to incorporate bismuth oxide without significantly affecting the properties of the material or instrument. Nanoparticles can be incorporated without affecting the properties and still achieving the desired radiopacity and without toxicity or carcinogenicity risk associated with heavy metals[7].

G. Orthdontic wires: Sandirk Nanoflex is a new stainless steel which allows ultra-high strength combined with good formability, corrosion resistance and a good surface finish[7].

H. Nano Sterilizing Solution: Gandy Enterprises Inc. Florida have introduced a new disinfectant based on super science of nano-emulsion technology. It uses nano-sized emulsifier droplets of oil (similar in size to HIV virus) that bombard the pathogens. Eg. Eco Tru Disinfectant[6]

ADVANTAGES:

- Broad spectrum
- Hypo allergic
- Noncorroding
- Does not stain fabric
- Requires no protective clothing
- Environment friendly
- Compatible with various impression materials

2. INDUCTION OF LOCAL ANESTHESIA

To induce local anesthesia in the era of nanodentistry, a colloidal suspension containing millions of active analgesic micron-size dental nanorobots will be instilled on the patient's gingivae which can crawl through the mucosa, lamina properia and dentine painlessly reaching the pulp in around 100 seconds. Upon reaching the pulp these tiny machines will establish control over nerve impulse traffic which in turn can be controlled by the dentist on board. When the dentist presses the icon for the desired tooth on the hand held controller display, the selected tooth immediately numbs. After the oral procedures are completed, the dentist orders the nanorobots to restore all sensations, to relinquish control of nerve traffic, and to egress from the tooth by similar pathways used for ingress[1].

ADVANTAGES:

- Greater patient comfort
- No anxiety, no needles
- Greater selectivity and controllability of analgesia
- Fast and completely reversible
- No side effects and complications

3. TOOTH REPAIR:

Initially major tooth repair will be possible through combination of nanotechnology, genetic engineering and tissue engineering and later on whole tooth will be grown in vitro and installed in oral cavity. So complete dentition replacement therapy should become possible to undertake within the time and economic constraints of an ordinary office visit, using an affordable desktop manufacturing facility in the dentist's office[1,3].

4. TOOTH RENAURALIZATION

It is similar to tooth repair where all the previous fillings and caries will be removed and the lost tooth structure will be replaced with the remanufactured tooth structure to the best esthetic standard[1,6].

5. DENTIN HYPERSENSITIVITY

Dentin hypersensitivity is a pathological phenomenon. It is caused by pressure transmitted hydro dynamically to the pulp[1]. Mainly hypersensitive teeth have dentinal tubules with surface densities that are eight times higher than those of non sensitive teeth. Dental nanorobots can selectively and precisely occlude the specific tubules within a minute offering patients a quick and permanent cure.

6. ORTHDONTIC NANOROBOTS

Orthodontic nanorobots can directly manipulate the periodontal tissue, including gingivae, periodontal ligament, cemental and alveolar tissueallowing rapid and painless tooth straightening, rotating and vertical repositioning within minutes to hours[1].

7. NANOROBOTIC DENTIFRICES/ DENTIFROBOTS:

A subocclusal dwelling nanorobotic dentifrice delivered by mouthwash or tooth paste could patrol all supragingival and subgingival surfaces at least once a day, metabolizing trapped organic matter into harmless and odorless vapors. Properly configured dentifrobots could identify and destroy pathogenic bacteria residing in the plaque and elsewhere, while allowing the species of harmless oral microflora to flourish in a healthy eco system. They would also provide a barrier to halitosis[2,5].

Other applications of nanotechnology in dentistry may be periodontal drug delivery, non-invasive diagnosis, bioresorbable materials etc[1,6].

CONCLUSION:

The visions described above may sound unlikely, implausible, or even heretic. Yet, the theoretical and applied research to turn them into reality is progressing rapidly. Nanotechnology will change dentistry, health care and human life more profoundly than other

developments. Great things come with greater challenges and overcoming these challenges such as ethics regulation, human safety etc. will become the priority in the future.

BIBLIOGRAPHY

1. Frietas R.A.; Nanodentistry; JADA, 2000; 131; 1559-1565
2. Berger M.; Nanotechnology in my tooth paste; Nanowork Spottlight; www.nanowork.com
3. Bogedal M., Gleiche M.; Nanotechnology and its implications; www.nanoform.org
4. Christopher Roman; Superior dental composites; www. nanoproducts.com
5. Henkel; Nano active toothpaste; www.nannit-active.com
6. Jhaveri H.M., Balaji P.R.; Nanotechnology: the future of dentistry; JIPS; 2005; 5; 15-17
7. An application of Nanotechnology in advanced dental materials; JADA 2003; 134; 1382

Source of Support: *Nil,* ***Conflict of interest:*** *None declared*