

Yadav Ankita*, Thakkar Mosam**, Sonali Mahadevia***, Aatman Joshipura****

ABSTRACT

The nanotechnology has revolutionized in the field of science and technology in 21st technology. Nano dentistry is the science and technology of maintaining near-perfect oral health through the use of nanomaterials including tissue engineering and nanorobotics. Nanotechnology in orthodontics are applied in nano coated arch wires, nano brackets, nano composites, to prevent white spot lesions and biomechanical sensors for orthodontic forces and moments measurements. Its future application are in nano robotics in orthodontics, use of shape memory polymer in orthodontics, BioMEMS/NEMS for orthodontic tooth movement and maxillary expansion and nanolipus device.

Keyword: Nanotechnology, orthodontics, future application

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The advent of nanotechnology has revolutionized science in the 21st century. The terminology “NANOTECHNOLOGY” originated from greek word meaning “dwarf”^[3]. The concept of nanotechnology was based on the discussion in 1959 by renowned physicist Richard Feynman who described that it could be possible to directly manipulate the atoms.

NANO DENTISTRY is the science and technology of maintaining near-perfect oral health through the use of nanomaterials including tissue engineering and nanorobotics.^[4]

APPLICATION OF NANOTECHNOLOGY IN ORTHODONTICS

A. Nano coated arch wires

Friction plays a major role in alignment or retraction of teeth during orthodontic treatment. To overcome friction, we can use several methods like applying higher but it leads to undesirable anchor loss or to vary wire size and shape. Other alternative is to alter the bracket design or coating over the wire to reduce friction.

A recent innovation in the form of metal nanoparticle coating has been introduced that significantly reduces friction of various surfaces including archwires. The coating consists of electrodeposited Ni film impregnated with inorganic fullerene-like nanospheres of tungsten disulfide.^[5] Syed SS Kulkarni (2015)^[6] Used three types of orthodontic wires, stainless steel, titanium molybdenum and nickel titanium and coated them with a uniform and smooth nanoparticle film using

100 ml of nanoceramics with the sol gel thin dip coating method. The ESEM images were found to be smoother with less surface deteriorations than the conventional ones.

A. Nano Brackets

A new material which contained polysulfone embedded with hard alumina nanoparticles was developed in the year 2012 by UC3M for making orthodontic brackets. The material innovated had the properties of strength, reduced friction and biocompatibility while maintaining the transparency of the bracket^[7].

Advantages of the new material introduced by UC3M were

- Increase in mechanical and frictional resistance
- Maintenance of bracket transparency
- Better wear and tear resistance
- Biocompatible

C. Nano Composites

The latest advancement of nanoparticle technology in the domain of biomaterials is introduction of nanocomposites and nanoionomers. When inorganic phases in an organic/inorganic composite become nano-sized, they are called Nanocomposites.

Uysalet al. conducted a study in 2010 to evaluate the bond strength of nanocomposites and nanoionomers and have shown that these nanomaterials may be suitable for bonding in orthodontics as they fulfill the previously suggested

*PG Student, **PG Student, *** Head of the Department , ****Reader

DEPARTMENT OF ORTHODONTICS AND DENTOFACIAL ORTHOPAEDICS
AHMEDABAD DENTAL COLLEGE AND HOSPITAL, TA. KALOL, DIST: GANDHINAGAR, GUJARAT, INDIA.

ADDRESS FOR AUTHOR CORRESPONDENCE : DR. ANKITA YADAV, TEL: +917405820799

shear bond strength ranges for clinical acceptability.^[8]

A. To prevent white spot lesions

It is a well-established fact that the unaesthetic WSL caused due to demineralization is rightfully termed as the scars of orthodontic treatment.^[9] Plaque in association with fixed appliances can result in clinical problems such as demineralization of the adjacent enamel and gingival inflammation. Gold standard to prevent this is use of fluoride and chlorhexidine mouthwash. Major drawback encountered is epithelial desquamation causing altered taste sensation and brownish discoloration of teeth while using chlorhexidine mouthwash for prolonged periods.

Nano-hydroxyapatite has been introduced as nanotechnological advancement in the products for the remineralization of enamel. Medeiros et al. in their study in 2013 concluded that calcium nanophosphate forms a protective layer on the enamel surface and provides protection against erosion.^[10] In a comparative study by Carvalho et al. in 2013, on the effect of calcium nanophosphate and CCP-APP paste, it was concluded that calcium nanophosphate is a better remineralizing agent for eroded enamel surfaces.^[11]

A. Nanomechanical sensors for orthodontic forces and moments measurements

Researchers have been working towards development of brackets that can carry three dimensional mechanical sensors, to measure the real time forces that have been applied to the teeth.

In order to achieve this Lapatki (2007) proposed the introduction of “smart” bracket. A large size prototype bracket that utilized microsystem chip encapsulation. Development of the nano chip that can be encapsulated into small low profile bracket systems with reduced mesio distal and occluso gingival dimensions will allow the clinical testing of utilization of this technology.^[6,12]

FUTURE APPLICATION OF NANOTECHNOLOGY IN ORTHODONTICS

I. Nanorobotics in orthodontics

Orthodontic nanorobots working on acoustic data signals could directly manipulate the periodontal tissues, allowing rapid and painless tooth straightening, rotating and vertical repositioning

within minutes to hours. Nanorobots may be used for manipulation of tissues directly at nano level and research has begun on the use of nanorobotics for medical applications like drug delivery, management of aneurysms and tumors.

II. Use of shape memory polymer in orthodontics

Applications of nanoparticles in shape-memory nano-composite polymers can increase thermal conductivity of the polymers^[13,14]. These wires can also be made with clinically relevant levels of elastic stiffness. Once placed in the mouth, these polymers can be activated by the body temperature or photoactive nanoparticles activated by light and thus influence tooth movement. Future research directions in shape-memory nanocomposite polymers to produce esthetic orthodontic wires can be of interesting potential in orthodontic biomaterial research.

III. BioMEMS/NEMS for orthodontic tooth movement and maxillary expansion

BioMEMS- biological microelectromechanical systems. A term referring to the application of microelectromechanical systems to micro and nano systems for genomics, proteomics, drug-delivery analysis, molecular assembly, tissue engineering, biosensor development, nanoscale imaging, etc. Implantable bioMEMS have been used as biosensors for in vivo diagnosis of diseases and as drug delivery microchips^[15-17]. Nanoelectromechanical systems (NEMS) are devices integrating electrical and mechanical functionality on the nanoscale level.

IV. Nano lipus device

Ultrasound is a form of mechanical energy that is transmitted through and into biological tissues as an acoustic pressure wave at frequencies above the limit of human hearing, is used widely in medicine as a therapeutic, operative, and diagnostic tool^[18,19]. LIPUS has been reported to enhance bone growth into titanium porous-coated implants^[20] and bone healing after fracture^[21,22] and after mandibular distraction osteogenesis^[23] and has also stimulated mandibular cartilaginous growth^[24].

CONCLUSION

Nanotechnology in orthodontics is in its emergence phase. The addition of nanoparticles to currently available materials enhances their properties and clinical use. Use of nanotechnology in accelerating

orthodontic treatment, preventing white spot lesions, orthodontic bonding, nano coating proves out to be a niche for orthodontists. Application of nanotechnology should be further explored in the field of orthodontics.

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