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UNBINDING THE FUTURE WITH NANODENTISTRY IN DIAGNOSIS AND TREATMENT OF ORAL CANCER

Pathology

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ABSTRACT

There is an unavoidable development in the progress of science, nanotechnology has been part of the mainstream scientific theory with potential medical and dental applications since the early 1990s. Dentistry is undergoing another change with the help of nanotechnology combined with nanomaterials, biotechnology and ultimately dental nanorobotics.

Nanodentistry is an emerging field with significant potential to yield new generation of technologically advanced clinical tools and devices for oral healthcare . In particular, using Atomic force microscopy techniques- diseases such as oral cancer can be quantified based on morphological, biophysical and biochemical nanoscale properties from oral fluids, such as saliva.

Diagnosis of oral cancer can be done using nanoscale cantilevers, nanopores nanotubes and quantum dots whereas; it can be treated with the help of nanomaterials for brachy therapy, nanovectors for gene therapy and nonviral gene delivery systems etc.

KEYWORDS

Nanodentistry, Atomic Force Microscopy, Nanorobots.

INTRODUCTION

The term "Nanotechnology" refers to the science of manipulating matter, measured in the billionth of meters or nanometers, roughly the size of two or three atoms. It was first introduced in 1964 by Norio Taniguchi (University of Tokyo). Nanodentistry is defined as the application of nanotechnology to diagnose, treat and prevent oral diseases like oral cancer. The term "Nanodentistry" was first introduced in 2000 by research scientist Robert Freitas.[1]

NANOPARTICLES

Nanoparticles are defined as small objects that behave as a whole unit in term of its transport and properties. Fine particles have the range of 100 to 2500 nm or ultrafine particles having the size of 1 to 100 nm. [1]

Multifunctional nanoparticles have been developed for :[1]

- Targeting
- Imaging
- Drug delivery
- Sensing of anticancer agents
- Small interfere RNA (si RNA) delivery

NANODEVICES

Nanodevices detect cancer cells and identify cancer signatures. They also help in targeted delivery of anticancer therapeutics to tumor cells. This novel imaging tool can lead to significant improvement in cancer therapy due to earlier detection, accurate staging and microtumor identification.[2]

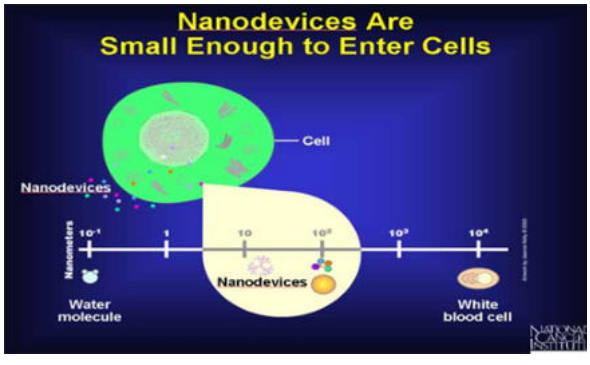

Fig 1: Nanodevices

NANOPARTICLES IN ORAL CANCER DIAGNOSIS QUANTUM DOTS

Semiconductor quantum dots are extremely small particles of cadmium selenide (Cd Se) or zinc sulphide whose sizes are in the range of 1 to 10nm. Quantum dots probes could be conjugated to monoclonal antibodies for oral cancer-specific antigens, such as epidermal growth factor receptor, to **detect oral cancer cells specifically.**[3]

OPTICAL DETECTION TECHNIQUE

Detect the presence of cancer with the assistance of biomarker or functionalized nanomaterials, where nanoparticles either fluoresce or change their optical properties when they bind to cancer-affected tissue.[4]

MICRO AND NANO-SCALE CANTILEVER ARRAYS

They are developed for **an ultra sensitive bio-assay.** These cantilevers can bond with specific reagent to detect and measure **the presence of particular antigens** and / or complementary DNA sequence. They detect disease at **much earlier stage.**[3]

NANOPORE

They contain tiny hole and allows DNA to pass through one strand at a time making **DNA sequencing more efficient.** Further advantages are-[5]

- **Shape and electrical properties** of each base on the strand can be monitored.
- Properties are unique for each of the four bases that make up the genetic code.
- Passage of DNA through a nanopore can be used to **decipher the encoded information**, including errors in the code known to be associated with cancer.

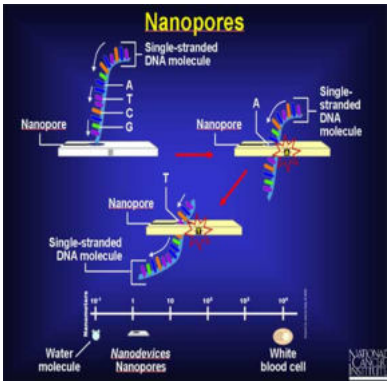

Fig 2: Nanopores

NANOWIRES

Nanowires are glowing silica wires in nanoscales. The nanowire based delivery enables simultaneous detection of multiple analytes such as cancer biomarkers in a single chip, as well as fundamental kinetic studies for biomolecular reactions. [5]

ORAL FLUID NANOSENSOR TEST

- **Multiplex detection of salivary biomarkers for oral cancer.**[5]
- Combination of two salivary proteomic biomarkers and four salivary mRNA biomarkers.[5]
- **High specificity** and **sensitivity.**[5]

Fig 3: Oral Fluid Nanosensor Test

GOLD NANOPARTICLES

Gold Nanoparticles exhibit a unique optical response to resonantly scatter light **when** excited at their **Surface plasmon resonance frequency.** Epidermal growth factor receptor (EGFR) is a cell surface receptor biomarker that is overexpressed in epithelial cancer but not in normal cells. Anti EGFR antibody conjugated nanoparticles specifically and homogeneously binds to the surface of the cancer cells with 600% greater affinity than to the non cancerous cells. It elicit an optical contrast resulting in a visible colour change from red to purple or gray.[6]

NANOPARTICLES IN TREATMENT OF ORAL CANCER

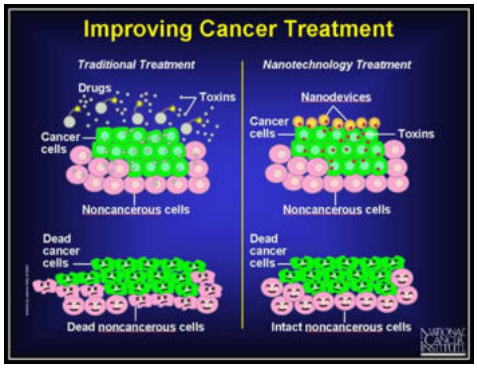

Fig 4: Nanoparticles In Treatment Of Oral Cancer

NANOCAPSULES

They are tiny containers the size of a virus and penetrate through small capillaries. They deliver drugs and other materials with 100% efficiency to targeted cells.[6]

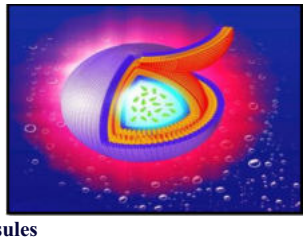

Fig 5: Nanocapsules

CARBON NANOTUBES

Carbon nanotubes consist of carbon atoms exclusively arranged in a series of condensed benzene rings rolled-up into tubular architecture. When exposed to near-IR light, carbon nanotubes quickly release excess energy as heat (~70^{0}C) which can kill cancerous cells.[7]

POLYMERIC MICELLES

They are currently recognized as one of the most promising nanocarrier system for **drug and gene delivery** in the treatment of cancers.[7]

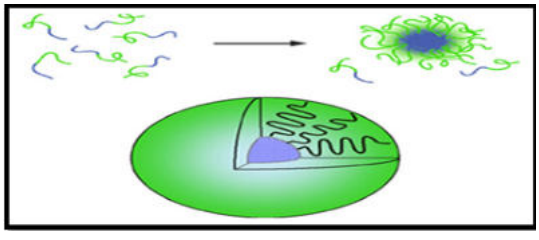

Fig 6: Polymeric Micelles

FULLERENE- BASED DERIVATIVES

These are crystalline particles in form of carbon atoms that has huge potential in cancer therapy. The cage structure of fullerene is ideal for attaching anticancer agents or even radiological agents to increase treatment efficacy for eradication of cancerous cells.[8]

MAGNETIC NANOPARTICLES

The effect of magnetic nanoparticles is due to **super paramagnetic iron oxides,** typically Fe_2O_3 and Fe_3O_4, which do not retains their magnetic property when removed from the magnetic field. Their paramagnetic characteristics have made them good candidate for **the destruction of tumors in vivo through hypothermia.**[9]

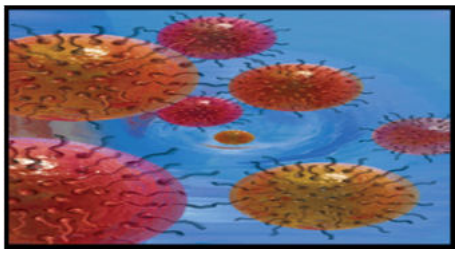

Fig 7: Magnetic Nanoparticles

CANCER NANOVACCINES

Cancer nanovaccine could be designed, manufactured and introduced into the human body to improve health including cellular repairs at the molecular level.[4]

NANOROBOTS

They are a size of a bacterium and composed of many thousands of molecule-size mechanical parts resembling macroscale gears, bearings, and ratchets. Nanorobots could be programmed to quickly recognize and digest even the tiniest aggregates of early cancer cells. Medical nanorobots could also be used to perform surgery on individual cells.[6]

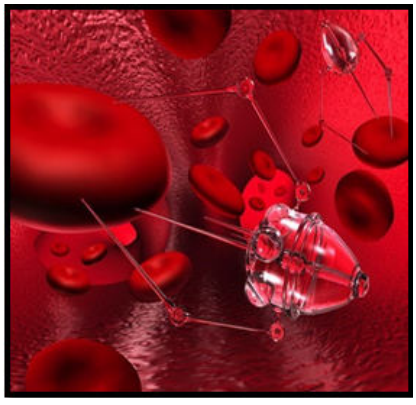

Fig 8: Nanorobots

CONCLUSION

Nanodentistry can diagnose malignant disease at the earliest opportunity and allows treatment options to be planned as early possible replacing high invasive conventional cancer treatment like irradiation and painful therapies. It directly affects the morbidity and mortality of head and neck cancer.[8]

REFERENCES

1. Mikkilineni M, Rao A S, Tummala M, Elkanti S . Nanodentistry : New buzz in dentistry. Eur J Gen Dent 2013; 2:109-13.
2. Virupakshappa B. Applications of Nanomedicine in Oral Cancer. Oral Health Dent Mang.2012;11(2): 62-8.
3. Alok A , Paanat S , Aggarwal A , Upadhyay N , Agarwal N , Kishore M. Nanotechnology : A boon in oral cancer diagnosis and therapeutics SRM J Res Dent Sci 2013 ; 4: 154-60.
4. Ferrari M. Cancer Nanotechnology: Opportunities and challenges. Nat Rev Cancer. 2005;5 :161-171.
5. Jeremy J Ramsden. What is nanotechnology? Nanotechnology perception.2005 ;(1):3-17.
6. C.S Sindhura, Babu N.C, Vinod. Nanobiotechnology in detection and treatment of oral cancer. J Adv Med Dent Science.2013;1(2):66-77.
7. Huang X, Jain PK, EI-Sayed IH, EI-Sayed MA. Gold nanoparticles : interesting optical properties and recent applications in cancer diagnostics and therapy. Nanomedicine. 2007;2:681-693.
8. Prabhu V, Uzzaman S, Grace VM, Guruvayoorappan C. Nanoparticles in drug delivery and cancer therapy. Journal of Cancer Therapy.2011;2(3):325-334.
9. Suri SS, Fenniri H, Singh B. Nanotechnology – based drug delivery systems. Journal of Occupational Medicine and Toxicology.2007;2:1-6.