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Research Article

ROLE OF SCIENCE AND TECHNOLOGY IN ENHANCING THE EFFECTIVENESS OF INTERDISCIPLINARY DENTISTRY

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ABSTRACT

The present review discusses about the science and technology in dentistry. The enormous growth of science and technology has lead to a giant leap in the dentistry. Understanding its development is a key to update us in the field. The role of technology has advanced the field of science right from advanced diagnosis to advanced treatment options. So having a thorough knowledge in the recent advances is important to practice effective dentistry.

Key Words:

Dentistry . Nanodentistry , Tissue Engineering , Biomimetics , Molecular Biotechnology , Digitalization , Science and Technology ,

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INTRODUCTION

Science and technology is a miraculous terminology that has refurbished the modern world. Twentieth century is an era of humankind as well as dentistry where major scientific and technological advances took place which has changed the concepts and trends of dentistry in all the aspects starting right from diagnosis, treatment and prevention. The recent headways of science and technology pertaining to interdisciplinary dentistry are to be discussed here.

There are various divisions in dentistry where the scientific advances are technologically illustrated and brought to limelight. Still the concepts of the science like genetics, molecular tissue engineering, etc., are discussed separately from the technological advances for the purpose of clarity.^(1,2)

Scientific Breakthroughs in Interdisciplinary Dentistry Pertaining To 20th Century

The scientific Advances are Discussed in the Following Categories

1. Molecular biotechnology
2. Genetics
3. Tissue engineering
4. Personalized medicine

5. Bio - mimetics

Role of Molecular Biotechnology in Interdisciplinary Management

Molecular biotechnology is a field which created a revolution in dentistry⁽³⁾. Along with bio-informatics this field has lead to its expansions like proteomics, metabolomics, genomics and transcriptomics. These techniques help us analyse various local, environmental and genetic risk factors and their markers like microbial products, biomarkers, even with minute fragments of DNA related to two major disease of oral cavity – dental caries and periodontal disease by means of enormous tools like

1. PCR ,
2. Microarrays ,
3. Blotting ,
4. Gel electrophoresis and
5. Gene expression analysis.

Some Common Biomarkers Evaluated are

1. IL-1(Interleukin – 1), TNF-ALPHA(Tumour necrosis factor – alpha), MMP(Matrix metalloproteinase), LPS (Lipopolysaccharide), etc., (Periodontal

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- disease & bone remodelling) in the field of periodontics and orthodontics.
- 2. Micro-organisms (periodontal & cavity related)
- 3. Enzymes and enzymatic products (related to caries and periodontal disease) , etc.,
- ✓ These tools also play an important role in forensic odontology like evaluation of bite marks , mass disaster , etc., by DNA identification.
- ✓ Also these measures help in management of various dental and alveolar defects by molecular delivery agents (eg., BMP-Bone Morphogenetic Protein) in management of dental caries , periodontal defects and other tooth abnormalities.

Role of Genetics in Interdisciplinary Appraisal

Genetics and gene therapy are ruling the regenerative strategies of 20th century. Gene therapy is explained by Bayertz *et al* & Freidmann *et al* “ as insertion of specific genes into an individuals’ cell to treat an inherent disease.”⁽⁴⁾

The Various Strategies of Gene Therapy Include

1. Germ line gene therapy
2. Somatic gene therapy

The two types of transfection of genes are ex-vivo & in-vivo by means of various viral and non-viral vectors.

Gene therapy is applied in various field of dentistry.

- Regeneration of bone pertaining to bone loss by means of trauma, neoplasia, various inherent congenital defects / deformities.
- Regeneration of lost periodontium. Targeted gene delivery for regeneration of lost periodontal and peri-implant tissues
(eg. Growth factors - PDGF (Platelet Derived Growth Factor), TGF-beta (Transforming Growth Factor – beta). Transcription factors like – RunX2, Osterix, ECM proteins – osteopontin, bone sialoprotein, etc.,)
- Supplement of growth genes transfer in salivary glands and keratinocytes (regeneration, remineralization, anti-caries)
- Gene addition therapy (regeneration)
- Antisense RNA therapy
- Cyto-reductive therapy (management of cancer)
- Immunological therapy (management of cancer)

Crispr – It is a genome editing method. they deal with a CRISPR / cas 9 system of RNA endonuclease. This is a future of genetics which enables genetically designed babies which are free of cancer.

Role of Tissue Engineering in Interdisciplinary Management

- ✓ Tissue engineering which initially worked on a triad, now works on four principles namely scaffold, cells, signalling molecules and vascularity
- ✓ In the year of 2000 the stem cells were first isolated from 3rd molars of human.⁽⁵⁾
- ✓ This provided a pathway in regeneration of lost orofacial tissues.
- ✓ Langer and Vacanti were first to apply the tissue engineering principle and explained it as an

“interdisciplinary field” to restore, improve / maintain the function of a tissue by its substitutes.

- ✓ This is applied in various aspects of dentistry like
 1. Root canal revascularization
 2. Pulp implantation⁽⁶⁾
- 1. 3-D cell printing technology(for regeneration of pulpal & periodontal tissues)
- 2. Targeted gene therapy
- 3. Various growth and differentiation factor supplementation in periodontal regeneration
- 4. Perio-aesthetics (scaffolding , carrier of biomaterials , hydrogels)
- 5. Management & regeneration in craniofacial deformities
- 6. Alter gene expression in craniofacial carcinomas

Concept of Personalized Medicine

- Personalized medicine is a strategy that is based on the “SYSTEMS BIOLOGY CONCEPT” which is a holistic approach that involves a customized health care starting right from diagnosis to treatment .
- This is a precise health care measure that utilizes the four “omics” along with clinical sketch of the patient to achieve a not previously possible measure of precision.⁽⁷⁾

Its role in Effective Interdisciplinary Dentistry be

1. To evaluate the specific risk factors (like bacteria , smoking , diabetes , etc.,)
2. To evaluate IL-1 positive gene
3. Prevention of dental caries by means of enzyme blocking agents
4. Prevention periodontal disease by preventing biofilm adherence
5. Prevention of cancer - To deliver prompt prophylactic therapy for patients who are in the verge of cancer risk.
6. Management of cancer – rational drug design & prevention of recurrence.

Biomimetics

Biomimetics is a term which goes hand in hand with the terms which are previously discussed. It primarily aims at providing a substitute for lost oro-facial tissues to rehabilitate function.⁽⁸⁾

Various Biomimetic Approaches that can be Used in Dentistry are

1. Stem cell based pulpal & periodontal regeneration
2. Pulpal implantation
3. Injectable scaffold delivery with biomaterial , hydrogels , growth factors , etc.,
4. Targeted gene therapy
5. Biomimetic self assembling peptides(to provide ionotrophic effect and increase mineralization eg:- P11-4 switch)

And then the final invention being the future of dentistry –

“Bioengineered Tooth” or “Bionic Tooth”

The concept suggests that preservation of mesenchymal stem cells with retained ability to form & maintain tooth. By means of this , stem cells based regeneration of tooth / tooth like structure which resembles its anatomy & function.⁽⁹⁾

Role of Technological Advances

Preventive Care

Newer aids in the oral hygiene maintenance are discussed below:

1. AMABRUSH – automated full mouth toothbrush , with self dispensing tooth paste
2. WATERPIK- water floss irrigation system
3. SMART TOOTH BRUSH – with a inbuilt sensor which track the time , area and pressure of brushing and gives alerts by means of mobile applications.
4. NANOCHIPS implanted in mucosa with sustained release agents which hinder biofilm adhesion
5. WEARABLE TOOTHPASTE: with antimicrobial carbon nanotubes aiding in remineralization

Digital Dentistry

- ✓ This deals with a range of technologies starting right from patient records , photographs , prevention , digital diagnosis , 3D model development & restoration with advanced S-ray scanning which can even detect minor cavities / cracks / bone loss⁽¹⁰⁾
 - ✓ The recent advances of digital dentistry(20th century) are
1. Intraoral scanners – microchipped intraoral camera which captures digital imaging .
 2. VELscope - a non-invasive oral cancer screening device with scanner that utilizes reflection & mucosal abnormalities
 3. 3D printing / BIO- Printing – with help of these above mentioned scanners the lost teeth and architecture with occlusion is evaluated and 3D milling done .
 4. Augmented reality – Gone are the periods where the patient is trialed for a treatment with wan mould ups . Now with intraoral scanners the virtual model with defect is created and with a softwareit helps alter the tooth shape , size , shade , form before final treatment
 5. Guided implant surgery – a virtual imaging of the jaws are done with virtual implant placement , which is replicated with soft splints to reality

Nanodentistry⁽¹¹⁾

Nanotechnology is ruling dentistry by means of the following branches:

Nano Tissue Engineering – usage of nano cellular and mineral components (like hydroxyapatite nanotubes)which would be able to regenerate tooth

Nano Robotics –Local anesthesia , Hypersensitivity care ,

Dental biomimetics ,
Dental durability and cosmetics , and
Renaturalization procedures.

Nano diagnostics – Nanoscale cantilevers

Nanopores
Nanotubes
Quantom dots
Nano electromechanical systems

Nano materials – Nanocomposites

Nanosolution
Nano-optimized mouldable ceramics

Nanoneedles
Nano structured implants
Nanomedicines

Future Trends in Nano Dentistry : Ozone therapy.

Future of Technologies in Dentistry

Painless Anesthesia

No more needle pricks to continue to apprehend the dental procedure. Now by means of patches, an electric current is passed in a circumscribed area. This technique is called iontophoresis . this creates a longer anesthetic period.⁽¹²⁾

Robotic Dentistry

- ✓ Reportedly in start of 2017 it is said that digital 3D printed teeth was prepared and implanted in an automated manner.⁽¹³⁾
- ✓ In September 2017 the first robotic implant has been staged. Without any human skilled assistance the robot has placed dental implant in human oral cavity successfully in a pre-programmed manner.

4D Systems: Going beyond the 3-dimensional recording , now a newer 4-dimensional system is invented which captures the 3D structure of tooth along with real time jaw movement which makes it 4D. This is proven to provide prosthesis and restoration of utmost precision.⁽¹⁴⁾

CONCLUSION

Starting from visual diagnostics manually with shining dental instruments to the verge of treating patients without a need to touch the patient – defines the spectrum of growth in dentistry. Though discussed as separate categories , all the technologies are inter-related which complement one technology to the other and one specialization to the other. It is our duty to cherish the growing technologies by updating ourselves in the knowledge and adapting ourselves to the searing changes for a better future of interdisciplinary dentistry.

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