

Study on Impact of Biomedical Engineering in Dentistry

Ishita R. Das¹, Milton K. Debnath², Rozina Akter³, Anita L. Jackson⁴,
Md. Zakir Hossain^{5*}

^{1,2,3,5}Department of Biomedical Engineering, JUST Medical Center, Jessore University of Science and Technology, Jessore, Bangladesh

⁴Department of Pharmacotherapy and Experimental Therapeutics, UNC Eshelman School of Pharmacy, University of North Carolina (UNC), Chapel Hill, NC-27599, USA

***Corresponding author:**

Prof. Dr. Md. Zakir Hossain, Chairman and Associate Professor, Department of Biomedical Engineering, Jessore University of Science and Technology, JUST Medical Center, Jessore, Bangladesh

Abstract— *Dentistry is a major branch of medicine. It deals with the study and the diagnosis, treatment and prevention of diseases of the oral cavity, adjacent structures and tissues [1]. Biomedical engineering is an interdisciplinary branch of engineering science that deals with the application of engineering principles in the field of biology and medicine for the betterment of health [2]. Being an ancient branch of medicine, dentistry largely needs a lot of technical instruments for its purpose to serve its patients [3].*

Keywords— *Biomedical Engineering, Applications, Dental Science, Impact.*

I. INTRODUCTION

Daily new biomedical technologies and scientific revolutions are observed in the field of dentistry that helps to expand diagnostic and treatment practices. Most of the modern dental diagnostic and treatment tools stem from biomedical engineering directly or indirectly [4]. Biomedical engineering is thus, related to dentistry by the development of newer tools and materials for diagnosis, treatment and preventive purposes. The effects of biomedical revolutions are mostly seen in both clinical practice and academic side of dentistry. In the coming years, personalized dental medicine, biomimetic, nanotechnology, genomic information, regenerative dentistry and stem cell studies will be more developed and integrated into dental practice [4-5]. Application of these new technologies will provide new solutions for traditional oral health problems as well as for the major dimensional changes in the field of dental science to emerge [5].

II. PURPOSE OF THIS STUDY

Daily new biomedical technologies and scientific revolutions are observed in the field of dentistry that helps to expand diagnostic and treatment practices. Most of the modern dental diagnostic and treatment tools stem from biomedical engineering directly or indirectly [4]. Biomedical engineering is thus, related to dentistry by the development of newer tools and materials for diagnosis, treatment and preventive purposes. The effects of biomedical revolutions are mostly seen in both clinical practice and academic side of dentistry. In the coming years, personalized dental medicine, biomimetic, nanotechnology, genomic information, regenerative dentistry and stem cell studies will be more developed and integrated into dental practice [4-5]. Application of these new technologies will provide new solutions for traditional oral health problems as well as for the major dimensional changes in the field of dental science to emerge [5].

Advancement in the discipline of biomedical engineering related technology has been used to better explain many of the dental problems like dental caries, periodontal diseases, tooth injuries etc. [5-8]. The ultimate use of these technologies is to focus on the patient's comfort and improvement of oral health [5-7]. At present knowledge about vaccine, cloning, DNA, drugs, tissue engineering, microbial bioinformatics and complex proteins are used in novel research on oral health to find out the best solutions for dental problems [8-9]. Some technological inventions in modern dentistry to enrich this field include computer assisted design (CAD), computer assisted manufactured (CAM) technology, continuous liquid interphase printing (CLIP using Carbon 3D) laser dentistry, oral cancer screening (for example, VEL scope) device, dental implant, digital X-ray, intraoral camera, composite resins, various biomaterials and so on [5-6, 10]. Basically, biomedical engineering is one of the most evolutionary fields to continuously interface with the best emerging dental technology for the patient's benefit [6]. These dental technologies are the fruits of applying bio-engineering knowledge in the field of dental science and innovative dental practice.

Dental practitioners commonly face two important diseases throughout their professional life [11]. These are tooth decay and periodontal disease. The complex natures of these diseases occur due to bacterial, genetic and environmental factors [11]. Amplifying and analyzing of nucleic acid through the polymerase chain reaction (PCR) uses specific DNA fragments to detect particular proteins. Using this PCR brings out a remarkable change in dentistry to diagnose periodontal diseases [11-12]. In biomedical sciences and engineering, the PCR is used to identify various microorganisms, chromosomal disorders, tumor suppressor genes, tumor associated translocation and analysis of mutation in oncogenes [11]. The application of PCR in dentistry is used to detect the periodontal carcinogenic pathogens, presence of viruses in host cells, microorganisms in endodontic infections, diagnosis and prognosis of oral cancer and the estimation of quantity of different microorganisms [12]. Use of these molecular techniques, like PCR, can allow dentists to understand underlying conditions and to help to design appropriate treatment protocols for the periodontal disease at the molecular level [11].

Currently, biomedical engineering technology in tissue engineering and bone regeneration has had significant impact in dentistry. Many bone defects like injury of the bone, periodontal disease and congenital disorders are considered as major health problems which can be treated with biomedical sciences and tissue engineering technology. Present strategy of tissue engineering technology is aimed at bone morphogenetic proteins (BMPs), which induce bone formation [13]. On the other hand, whole tooth regenerative treatment has also been influenced by the application of tissue engineering technology. The embryonic development and biological analysis of stem cell reveals the physiological function of the tooth. This function has been improved by the replacement of a bioengineered tooth germ that results a successful eruption of correct tooth structure in the oral cavity [8, 14]. These remarkable advances provide the gene-based treatment process in the field of dentistry [15]. In the next few decades, genetic engineering will be more effective in dentistry. It will encourage the body to repair itself by the artificial placement of extrinsic materials [4].

III. CONCLUSION

To conclude, biomedical engineering helps to develop dentistry and has brought a revolutionary change in dental science. Many new inventions and discoveries are knocking at the door which will open a new horizon to solve dental problems more easily and effectively. Thus, the collaborative research integration of biomedical engineering is undeniable for dentistry and has paved the way for future biomedical engineers to contribute more and more in dentistry through research, discovery and innovative new practice modalities.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

ETHICAL APPROVAL

This article does not contain any studies with animals performed by any of the authors.

ACKNOWLEDGEMENT

The authors has acknowledged the contribution of the University Grants Commission (UGC) and Jessore University of Science and Technology, Bangladesh for funding the research work.

REFERENCES

- [1] "Glossary of Dental Clinical and Administrative Terms". American Dental Association. Retrieved 1 February 2014.
- [2] John Denis Enderle; Joseph D. Bronzino (2012). Introduction to Biomedical Engineering. Academic Press. pp. 16-. ISBN 978-0-12-374979-6.
- [3] Suddick, RP; Harris, NO (1990). "Historical perspectives of oral biology: a series". Critical Reviews in Oral Biology and Medicine. 1 (2): 135–51. doi:10.1177/10454411900010020301. PMID 2129621.
- [4] YeganeGuyen; Scientific basis of dentistry; J Istanbul Univ Fac Dent. 2017; 51(3): 64–71. Published online 2017 Oct 2. doi: 10.17096/jiufd.04646
- [5] Walter Kostrzewski, DMD; Dental Technology; ACE dental education; <http://www.acedentalresource.com/dental-procedures/dental-technology/>
- [6] Top 10 New Technologies in Dentistry; 123Dentist.com; Community dentistry network; August 14,2012. <https://www.123dentist.com/top-10-newtechnologiesin-dentistry/>
- [7] Assunção WG1, Barão VA, Tabata LF; Biomechanics studies in dentistry: bioengineering applied in oral implantology;Pubmed; 2009 Jul;20(4):1173-7. doi:10.1097/SCS.0b013e3181acdb81.<https://www.ncbi.nlm.nih.gov/pubmed/19568186>

- [8] Oshima M1,2, Tsuji T3,4,5. Whole Tooth Regeneration as a Future Dental Treatment. Pubmed; 2015; 881:255-69. doi: 10.1007/978-3-319-22345-2_14. <https://www.ncbi.nlm.nih.gov/pubmed/26545754>
- [9] Ford P, Seymour G, Beeley JA, Curro F, DePaola D, Ferguson D, Finkelstein M, Gaengler P, Neo J, Niessen L, Oktay I, Park BK, Wolowski A, Claffey N. Adapting to changes in molecular biosciences and technologies. *Eur J Dent Educ*. 2008;12(Suppl 1):40–47. doi: 10.1111/j.1600-0579.2007.00479. x.
- [10] ThirugnanaSambandham, K. M. K. Masthan, M. Sathish Kumar, Abhinav Jha (2013); “The Application of Vizilite in Oral Cancer”. *J Clin Diagn Res*. 2013 Jan; 7(1): 185–186. doi: 10.7860/JCDR/2012/5163.2704
- [11] Intini G. Future approaches in periodontal regeneration: gene therapy, stem cells, and RNA interference. *Dent Clin North Am*. 2010;54(1):141–155. doi: 10.1016/j.cden.2009.09.002.
- [12] Vaid N, Choudhary P, Bansal P, Bhargava K, Bhargava D. Polymerase chain reaction & its applications in dentistry. *European J Pharmaceutical Med Res*. 2016;3(12):185–189.
- [13] Darnell Kaigler, B.S.; David Mooney, Ph.D.; Tissue Engineering’s Impact on Dentistry; *Journal of Dental Education* Volume 65, No. 5; Submitted for publication 1/31/01, accepted for publication4/9/0; <https://pdfs.semanticscholar.org/9ef9/59bd9a936b712d84d5daca42905aaa29b84b.pdf>
- [14] Wang Y1, Preston B, Guan G; Tooth bioengineering leads the next generation of dentistry; *Int J Paediatr Dent*. 2012 Nov;22(6):406-18; doi: 10.1111/j.1365-263X.2011.01206.
- [15] Maheshwari S, Verma SK, Tariq M, Prabhat KC, Kumar S. Emerging trends in oral health profession: The molecular dentistry. *Biology and Medicine*. 2010;2(4):56–63.