

THE FUTURISTIC TRENDS IN DENTAL SCIENCES

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I. INTRODUCTION & EVOLUTION OF DENTISTRY- TRENDS AND FUTURE

Introduction to new book why? When already so many books exist at the same topic? It is because; in the first place every author is highly appreciated and their work is recognized. Each of the books has given the experienced author to share their knowledge and research skill for the betterment of next generation students. With my work of teaching experience and my mentor's guidance I present this topic in a simplicity style and adaptive by every student in academics and daily practice.

Since the ancient civilizations, dental science has come a long way. The primitive dental treatments were rudimentary and mostly accompanied by myths and superstitions. The Ancient Egyptians used bees wax and metals for dental work, but with great pioneers like Pierre Fauchard (The Father of Dentistry) in the 18th century and many work from such pioneers, dentistry has continually evolved, benefitting millions worldwide [1].

Primarily, remedying dental pain was of more importance rather than preventive measures, however in recent times with evolving 22nd century, dentistry has entered a phase of technology advancement era where designing perfect smiles and good oral health are achievable for everyone.

Owing to unprecedented factors, such as sudden pandemic outburst of COVID- 19, dentistry has been going through a period of significant transformation thus this book gives you a brief insight about all the futuristic trends of dental industry.

The latest technological innovation with digital transformation in dentistry, which is built on electronic health data information, is the major game-changer of the 22nd century, where one can handle present and upcoming challenges in dental and oral health smartly. The ongoing progress in information technology (IT) has simplified the outcomes and made it possible to overcome the limitations and hurdles that existed in clinical dentistry. Some of the digital processes that has already been integrated into treatment protocols, are mainly in the field of rapidly growing branch of computer-aided design/computer-aided manufacturing (CAD/CAM) and rapid prototyping (RP) [2].

The scope of dental radiology has broadened in recent years to encompass automated processing in radiological imaging using artificial intelligence (AI) and machine learning (ML). Moreover, it is on the technological basis that the augmented reality (AR) uses the real-world scenarios and incorporates the virtual reality (VR) on top of it to enhance the experience. AI superimposes the large imaging files creating a platform where dental patients

can visualize virtually the non-invasive simulations and learn about different outcomes prior to any clinical intervention [2].

Recent advancement of artificial intelligence (AI) in dentistry, its impact in the dental office and dental colleges are not routine and still found to be under limited use. However, these technologies have made its application in certain fields such as, robotic assistance, dental image diagnostics, caries detection, radiography and pathology and electronic recordkeeping [3].

The authors believe in two major realities, firstly “TODAYS VISION IS TOMORROW’S REALITY” and secondly as the science crosses the lines of many diverse disciplines and so one book cannot serve as a suitable refence for the student, hence to conclude “A SINGLE BOOK NO LONGER CAN COVER COMPLETELY ALL ASPECTS OF THIS CONSTANTLY EXPANDING FIELD” [4].

There has never been a golden age when man was free of disease and this was evident in excavations of ancient skeletons that showed rotten teeth. Additionally historical finding suggest that dental decay was found back in 4000 B.C. among the ancient Egyptians [5].

In the article of Indus Valley Civilization, dated back as far as 7000 BC, where archaeology evidence of dental drilling using primitive tools were discovered for dental treatments [6].

Further evidence has shown that the Ancient Greeks and Romans had some dental knowledge for treating tooth decay, where they used mix of crushed bones, oyster shells, and eggshells, showcasing the ingenuity of early dental practices [7].

During the late Harappan period (Bronze Age - 2500 B.C. - 1500 B.C.) a jar with set of unusual teeth was found, it had a set of normal teeth, but few teeth had brownish ring of pigmented tartar around the middle area (gingival/alveolar margin). Scientific Studies using Ultraviolet emission spectroscope revealed that the pigmented tartar contained copper, however the copper metal was not present in the unstained part of normal (Harappan) teeth. The archaeological evidence suggests that probably a dentist of that period used copper or bronze strings for periodontal splintage in order to keep those defective loose teeth fixed on the jaw, as is now done in modern dental practice [1/5].

Sushruta (600 B.C), known as the “Universal Father of Surgery” invented about 1000 surgical instruments of all sorts. In a book called ‘Sushruta- Samhita’ (600 B.C. - 1000 A.D.) where all the surgical work methods were collected, it mentioned about the treatment of diseases of mouth, oral cavity, and throat in Nidanasthana (section 11, chapter 16) [5].

Fast forward to the present, the latest advancement in the field of dental science and dental technology is the world of digitalization. Revolutionized with 3D application in printing and intraoral scanning and treatment planning, dentistry has reached an extraordinary juncture, embracing new horizons in patient care that enables precision in treatments, reducing the chair time, and enhancing patient experience [8].

Change is inevitable and so is the same in dental field. Over the past decades dentistry has been evolving commendably and now is the time for dental professionals to keep up with upgrading trends for treating patients more efficiently in this competitive world.

II. EVOLUTION OF DENTISTRY CAN BE EMPHASIZED BROADLY ON THREE MAJOR ASPECTS

- **Evolution the Dental Materials Used:** More than evolution, the field of dental materials has undergone more of a revolution over the past 100 years. In the last few decades there has been introduction of many newly developed products into the market which has been growing impressive. Such changes are mostly appreciated in the area of improved aesthetics such as the gradual replacement in the restorative field from dental amalgam with dental composite. In the prosthetic field from all-metal to porcelain-fused-to-metal to full ceramic. Indirect restorations with reinforced dental ceramics, all made possible by the rapid improvements in dental adhesive materials [9].
- **Evolution and Application of the Dental Technology:** Ever since the first exploration of technology, three decades ago and its application in dentistry, dental industry has exponentially grown. Earlier days, applications of technology in dentistry were limited; moreover they were not capable of accurately capturing the complex anatomy of both hard and soft tissues of the oral cavity without distortion. Subsequent, as technology advanced, so did accuracy of the digital impression too. The ability to combine accurate digital impressions with 3-D digital radiographs furthermore aided with dental computer-aided-design (CAD) software, has opened multiple new treatment option workflows in various branches of dentistry like orthodontics, periodontics, prosthodontics, endodontics, pedodontics and oral surgery.
- **Evolution of Dental Education:** The dental education system is an area of ongoing work, requiring continual skills development and continuity in the field of research. As the science and technology of dental industry has progressed, the practice of dentistry has become easier and more sophisticated in clinical methods. The olden days of apprenticeship and self-trained and self-claimed competency are gone long ago and has been replaced by a long period of formal education. University-based schools of dentistry and postgraduate education in specialized fields of practice has become widespread and are easy to access.

However, despite the convergence of many areas, there are still fundamental disagreements about the relationship between dentistry practice and dental education. One of the fundamental disagreements is the bridging relationship between medicine and dental education. The issue of who should evaluate dental practice, and in what way, has been a source of controversy for over a multiple decade [10].

From understanding the historical changes through times of Ancient Egyptians to Indus valley civilization and moving towards the recent times where evolution in dental material, dental technology and dental education system were made, such a transition was achieved by pioneers because of the constant search for enhanced oral health care and patient care.

Many remarkable transformations and many revolutionary changes have been occurred in the field of dental sciences to embrace the futuristic trends that runs across the nine branches of dentistry. From acceptance of advanced technologies to its innovative implementation in the novel treatment paradigms, each division of dentistry has contributed to the evolution of the field. This chapter explores the latest trends in each of the dental branch and their potential implications for the future of dental care.

Popularity has been observed in the recent booming topics such as Tele dentistry, 3D Printing, Regenerative medicine and dentistry, Genetic engineering, Artificial Intelligence, Forensic dentistry, and Robotics dentistry.

- 1. DENTAL MEDICINE:** Tele dentistry has gained its popularity in pandemic covid-19 times and till date used as a popular alternative to in office consultations. Inter professional communications and multi-specialty approach for secondary opinion with respect to treatment aspect also has grown in tele dentistry considerably which is beneficiary to the doctor and the patient [11].
- 2. DENTAL RADIOLOGY:** The transition from making a conventional method X-rays to use of advanced digital imaging methods such as Cone-Beam Computed Tomography (CBCT) has revolutionized dental radiology. CBCT provides three-dimensional images that can be viewed in all aspect from a surgeon's point of operation; additionally, it has high resolution that aids in precise diagnosis and treatment planning. Further digital imaging reduces the radiation exposure for patients and it allows for easy storage of the data and images can be shared across the world [12].
- 3. RESEARCH DENTISTRY:** What fascinates the scientist across the world is the **Regenerative medicine (RM)**. It is an emerging medical field aiming to replacing or repairing human cells, tissues, or organs to restore the lost normal structure and its function (Cossu et al. 2018). It is the development of tools, which is mainly associated with genetic manipulation of cells, further added with bio engineered systems to program the cell fate and function is the newer milestone in the field of stem cell research science [13].

Like wise to regenerative medicine, **Regenerative dentistry (RD)** has opened doors to stem cell-based therapies, purely aiming at replacing the damaged or lost dental structures naturally.

The field of dental sciences promises even more remarkable innovations. Currently one such area gaining popularity is **Nano dentistry**. Nanotechnology could be applied for the diagnosis and treatment at the molecular level. As a mode of non-invasive innervations, it mainly allows for early detection of oral cancer and other diseases [14].

Additionally, research have shown that **Gene therapy in dentistry** could lead to personalized treatments, this is achieved by targeting individual genetic factors behind various dental tissues, making the way for customized preventive strategies. It opens a new way for restoring the oral tissues lost due to caries, periodontal diseases, and may be due to trauma.

This research area could widen the scope of dental science, where it allows for development of new teeth, could be known as the biological implants for missing teeth, where it follows two basic approaches vivo and ex vivo gene therapy [15].

Another interesting area that is being explored is the application of **Artificial Intelligence (AI)** in dentistry. **AI-driven robotic dentistry** is also being explored, showcasing the potential for precise and autonomous dental procedures [16].

4. **ORTHODONTICS:** In the recent years, considerable surge for the use of clear aligners, such as Invisalign has gained popularity and is a popular alternative to the traditional braces. As compared to the conventional fixed braces, these clear aligners have more advantages and acceptance for its properties such as transparency, easily removable, greater aesthetics and convenience for the patients seeking orthodontic treatment [17]. The combined use of computer-aided design (CAD) and computer-aided manufacturing (CAM) technologies, makes the invisible aligners more unique as it offers more personalized touch that ensure precise alignment and comfortable fit. The ability to visualize the treatment plan digitally allows for a better communication between the orthodontist and the patient, which in turn makes the dentist-patient connection more comfortable and evidentiary [18].
5. **ENDODONTICS:** In the quest of effective and hazard free precise work and fueled by recent advancements in cutting-edge technologies and innovative approaches, root canal treatment has gained popularity. Further reinforcement with newer instruments in treating the failed or broken file in the canal and newer medication for healing of periapical lesions and root canal sealers has given reassurance for longevity of tooth. The advent of regenerative endodontics has revolutionized the treatment of dental pulp and root canal related issues. This approach focuses on regenerating the damaged pulp tissues using stem cells and bioactive materials. Regenerative endodontics aims to promote the growth of new healthy pulp tissues, thereby enhancing the tooth's longevity and function. By harnessing the regenerative potential of the body cells, this trend offers a promising alternative to the traditional root canal therapies [19].
6. **PROSTHODONTICS:** Digital dentistry has proven to be a boon and has made a significant impact on prosthodontics. With the rise of three-dimensional (3D) printing technology, dentistry has changed over the past decade, where computer-guided implant placement and CAD/CAM technologies are used for precise positioning of dental implants, leading to better aesthetics and long-term success rates. 3D printing is a versatile technique that allows the fabrication of fully automated treatment plans, such as fabrication of crowns, bridges and dentures with superior accuracy and aesthetics, reducing chair side time for the patients [18, 20]. It is highly impressive, efficient, reproducible, and provides fast and accurate results in an affordable manner. With persistent efforts among dentists for refining their practice and dental skills, dental clinics are now getting acquainted and moving ahead from conventional treatment methods to a fully digital workflow in treating their patients.
7. **PERIODONTICS:** A rise in the minimally invasive techniques and patient acceptance for treating gum diseases and improving gum health has been observed prominently in the periodontics with the invent of laser therapy [21]. Laser therapy offers a less invasive and

more comfortable treatment option for patients with gum diseases. It targets and removes the infected tissues while promoting the growth of healthy gums. This approach results in faster healing and reduces post-operative discomfort, can be seen with implant site area [22].

- 8. ORAL AND MAXILLOFACIAL SURGERY:** The use of Virtual surgical planning (VSP) and computer-assisted navigation systems has transformed oral and maxillofacial surgeries. VSP allows surgeons to perform detailed preoperative stimulations, optimizing the surgical plans and minimizing the risks. Computer-assisted navigation systems provide real time guidance during surgery, enhancing precision and patient safety [23, 24].
- 9. ORAL PATHOLOGY:** Oral pathology has advanced through the integration of molecular diagnostics for more accurate disease detection and personalized treatment approaches. Salivary molecular diagnostics include salivary biomarkers analysis and genetic testing, allow for early detection of oral diseases and the identification of specific treatment targets. This personalized approach improves treatment outcomes and patient care [25].
- 10. DENTAL ANAESTHESIOLOGY:** It was in 1943 Wells, introduced the use of anesthesia during dental procedures [26]. However, the emergence of sedation dentistry has transformed dental anesthesiology providing a more comfortable experience for anxious patients. Sedation dentistry uses various levels of sedation, from minimal to deep sedation to help patient relax during the dental procedures thus revolutionizing patient mindset and treatment outcome. This trend enhances patient comfort making dental treatment more accessible to the individuals with dental phobia. The latest methods of sedation include Jet injections, Vibrotactile devices, Computer Control Local Anesthetic Delivery (CCLAD) System [27].
- 11. PEDIATRIC DENTISTRY:** Behavior therapy remains a cornerstone for the acceptance of digitalization and futuristic trends among the young patients. The use of innovative psychological techniques to alleviate dental anxiety and establish positive associations with oral care at an early age establishes a trust and cooperation in dentist, enabling a more successful dental visit at later stages of life. Nitrous oxide, employed by skilled pediatric dental aestheticians, has evolved into a refined tool for managing pain and anxiety, ensuring a relaxed experience during procedures. Remarkably, digital technology has permeated this field, with advanced imaging and augmented reality aiding in accurate diagnosis and interactive education, making dental visits engaging and informative for children, thus in this new era the pediatric dentistry branch forms a bridge where comprehensive care is seamlessly blended with psychological well-being and cutting-edge technology [28].
- 12. FORENSIC DENTISTRY:** Futuristic trends in forensic radiology are poised to revolutionize the field, where forensic imaging serves as an aid to explain and document findings for forensic and medico-legal purposes [29]. With digital advancements such as advanced imaging techniques, 3D reconstructions, and virtual autopsies, forensic experts to glean more accurate and comprehensive insights from post-mortem examinations. Furthermore, AI-powered algorithms are streamlining the analysis of radiological data,

expediting the identification of crucial evidence and patterns that might have been easily overlooked previously. These innovations hold immense potential for solving complex criminal cases, identifying causes of death, and reconstructing crime scenes with precision [30, 31]. The application field of forensic imaging has also been broadened and is recognized by more forensic practitioners like forensic pathology and forensic odontology [29].

III. CONCLUSION

As dental sciences advance, so does the emphasis on patient-centered care. Such evolution of futuristic trends in dental sciences is possible because of constant drive and commitment towards improving the patient care, optimizing treatment outcomes, and embracing the advancement in the technology. Additionally, the integration of artificial intelligence (AI) in dental practice not only offers virtual consultations; it also provides computer-aided diagnosis, treatment planning, streamlining processing and enhancing treatment outcomes. Thus, each division of dental school has contributed to the progressive transformation of the field offering exciting prospects for the future, promising more efficient, precise, and patient-centric dental care.

However, we cannot overlook the limitations; need to embrace it and overcome them. One such field is the National Institute for Dental and Craniofacial Research (NIDCR) centre, long recognized that despite significant research and advances in the basic sciences and engineering for dental and craniofacial regenerative medicine, very few advances and applications have made its way to the clinical practice to enhance patient health care delivery.

REFERENCES

- [1] Beeswax as dental filling on a neolithic human tooth. Federico Bernardini, Claudio Tuniz, Alfredo Coppa, Lucia Mancini, Diego Dreossi, Diane Eichert, et al. *Plos one*. 2012 Sep 19;7(9):1-9.
- [2] Recent Trends and Future Direction of Dental Research in the Digital Era. Tim Joda, Michael M. Bornstein, Ronald E. Jung, Marco Ferrari, Tuomas Waltimo and Nicola U. Zitzmann. *International Journal of Environment Research and Public Health*. 2020 march 18:2-8
- [3] Artificial Intelligence in Dentistry: Past, Present, and Future. Paridhi Agrawal, Pradnya Nikhade. *Cureus*. 2022 July 28;14(7):1-10.
- [4] Arthur H. Wuehrmann, Lincoln R. Manso-hing. *Dental Radiology*. 5th ed. London: CV Mosby company; 1981.
- [5] History of dentistry: An overview. Sisir K. Majumdar. *Bulletin of the Indian institute of History of Medicine*. 2002;32:31-42.
- [6] Palaeontology: Early Neolithic tradition of dentistry. A Coppa, L Bondioli, A Cucina, D W Frayer, C Jarrige, J-F Jarrige, et al. *Nature*. 2006 April 6;440(7085):755-756
- [7] Development of a novel dental filling using hydroxyapatite derived from waste oyster shells: Research. M.T.S Uresha, H.M.J.C Pitawala and G.G.N Thushari. *Journal of technology and value addition*. 2021;3(1):1-18
- [8] Additive Manufacturing Technologies Used for Processing Polymers: Current Status and Potential Application in Prosthetic Dentistry: Polymer Additive Manufacturing for Prosthodontics. Marta Revilla-León and Mutlu Ozcan. *Journal of Prosthodontics*. 2019 Feb;28(2):146-158.
- [9] The Evolution of Dental Materials Over the Past Century: Silver and Gold to Tooth Color and Beyond. S.C. Bayne, J.L. Ferracane, G.W. Marshall, R. van Noort. *Journal of Dental Research*; 2019 Feb 20;98(3):1-9.
- [10] Marilyn J. Field. *Dental Education at The Cross Roads: Challenges and Change*. Washington, D. C. National Academy Press; 1995.

- [11] Recent trends and Future Direction of Dental Research in The Digital Era. Tim Joda, Michael M. B, Ronald E. J, Macro F, Tuomas W and Nicola U. Z. *International Journal of Environmental Research and Public Health*. 2020 March 18;17(6):1-8
- [12] CBCT-Based Bone Quality Assessment: Are Hounsfield Units Applicable? R Pauwels, R Jacobs, S R Singer, and M Mupparapu. *Dento-maxillofacial Radiology*. 2015 Jan; 44(1):1-16
- [13] The Ethics of Regenerative Medicine. Goran Hermeren. *Biologia Futura*. 2021 Feb 20;72:113–118
- [14] Nanomaterials in Dentistry: Current Applications and Future Scope: Review. Pavan Kumar Pavagada Sreenivasalu, Chander Parkash Dora, Rajan Swami, Veeriah Chowdary Jasthi, Predeepkumar Narayanappa Shiroorkar, Sreeharsha Nagaraja, et al. *Nanomaterials* 2022 May 14;12:1-20
- [15] Gene Therapy: A Paradigm Shift in Dentistry. Review. Nida Siddique, Hira Raza, Sehrish Ahmed, Zohaib Khurshid, and Muhammad Sohail Zafar. *Genes* 2016 Nov 10; 7(11):1-12.
- [16] Robotics in Dentistry: A Narrative Review. Lipei Liu, Megumi Watanabe and Tetsuo Ichikawa. *Dentistry Journal*. 2023 Feb 24;11(3):1-15
- [17] Clinical effectiveness of Invisalign orthodontic treatment: a systematic review. Aikaterini Papadimitriou, Sophia Mousoulea, Nikolaos Gkantidis and Dimitrios Kloukos. *Progress in Orthodontics*. 2018 Sep 28;19(37):1-24
- [18] Application of CAD/CAM Technology in Dentistry. Naleen Naranje and Sawpnil C Mohod. *Journal of Research in Medical and Dental Science*. 2022 Oct 13;10(10):141-144
- [19] Regenerative Endodontic Treatment of Permanent Teeth after Completion of Root Development: A Report of 2 Cases. Khimiya Paryani and Sahng G Kim. *Journal of Endodontics*. 2013 Jul;39(7):929-34.
- [20] Computer aided design, computer aided manufacture and other computer aids in prosthetic and orthotics. B. KLASSON. *Prosthetics and Orthotics International*. 1985;9(1):3-11
- [21] Lasers in periodontics. Review. Sugumari Elavarasu, Devisree Naveen, and Arthiie Thangavelu. *Journal of Pharmacy and Bioallied Sciences*. 2012 Aug; 4(2):260-63.
- [22] Influence of low-level laser therapy on implant stability in implants placed in healed sites: a randomized controlled trial. Mateus de Azevedo Kinalski, Bernardo Antonio Agostini, Cesar Dalmolin Bergoli, and Mateus Bertolini Fernandes dos Santos. *International journal of implant dentistry*. 2021 Dec;7(49):1-7
- [23] Accuracy of virtual planning in orthognathic surgery: a systematic review. Ali Alkhayer, Jozsef Piffkó, Carsten Lippold & Emil Segatto. *Head & Face Medicine*. 2020 Dec 4; 16(34):1-9
- [24] Surgical Navigation for Oral and Maxillofacial Surgery. Nagi Demian, Craig Pearl, Timothy Charles Woernley III, James Wilson, Justin Seaman. *Oral and Maxillofacial Surgery Clinics of North America*. 2019 Nov;31(4):531-538
- [25] Scientific frontiers: emerging technologies for salivary diagnostics. B J Baum, J R Yates, S Srivastava, D T W Wong, and J E Melvin. *Advances in Dental Research*. 2011 Oct; 23(4):360-368
- [26] Horace Wells: Discoverer of Anesthesia. Peter H. Jacobsohn. *Anesth Prog*. 1995 Mar 21;42:73-75
- [27] Advances in dental local anesthesia techniques and devices: An update Review. Payal Saxena, Saurabh K. Gupta, Vilas Newaskar, and Anil Chandra. *National Journal of Maxillofacial Surgery*. 2013 Jan-Jun; 4(1):19–24.
- [28] Gerald Z Wright and Ari Kupietzky. *Behavior Management in Dentistry for children*. 2nd edition. Pondicherry: SPi Publishers services; 2014
- [29] Forensic imaging: a powerful tool in modern forensic investigation. Min Zhang. *Forensic Sciences Research*. 2022;7(3):385–92
- [30] Recent Advances in Postmortem Forensic Radiology. Benjamin Swift and Guy N Ruttu. *Postmortem Forensic Radiology*;4:355-404.
- [31] Artificial Intelligence with Radio-Diagnostic Modalities in Forensic Science - A Systematic Review. Shama Patyal and Tejasvi Bhatia. *CEUR-WS*. 2021 Sep 6;3058:1-11