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Dr Jason Griggs interviewed by Dr Amisha Parekh

By Dr Amisha Parekh
Dental Tribune South Asia

Dr Jason Griggs, Associate Dean of Research, School of Dentistry, University of Mississippi Medical Center (UMMC), who was recently awarded the prestigious Wilmer Souder Award by the International Association for Dental Research (IADR) for his outstanding achievements in dental materials research talks about his research journey and the future scope of dental biomaterial science in this interview with Dr Amisha Parekh, Head, Dental Biomaterials, Dental Tribune South Asia.

Dr. Jason Griggs advises the dental biomaterial science students to learn the basic principles of processing - structure - properties thoroughly. (Image: Dr. Jason Griggs)

First of all, congratulations on receiving the Wilmer Souder Award from IADR! Could you tell us what this recognition means to you personally and in your career?

It is a tremendous honour for me because I remember my mentor [Ken Anusavice] winning the Souder Award when I was a PhD student. Ken was a great scientist and a hard worker. Every time I am selected for an award or a service position that he held, I feel that I have somehow repaid the time that he invested in training me.

Can you tell us about some of your most impactful research projects or discoveries in dental materials science that you believe contributed to receiving this award?

Most of my work has been aimed at developing mechanical test methods that are more efficient. Some of the highlights were demonstrating that finite element analysis can be used to predict cyclic fatigue lifetime, developing a statistical model to predict the result of two forms of lifetime acceleration (overstress and usage rate acceleration) and their interaction, training artificial neural networks to predict the fatigue limits of implants, developing the only method so far for measuring the fracture toughness of clinically failed ceramics, settling the controversy regarding healing behavior of hydrothermal porcelains, and determining which specimen dimensions result in the best precision for strength tests and fracture toughness tests.

Can you tell us about how your journey in dental materials research began and what motivated you to pursue this career?

I was taking an undergraduate course in glass formulation at the University of Florida from Larry Hench, who was famous for designing bioglass. I decided not to waste this close contact with such a fine potential mentor, and I asked him for a summer research job. He said that he would wait to see how I performed in his course. I worked extra hard throughout the course, and when it came time to assign term projects each student chose a series of glass formulations for which to predict the structure and properties. Larry asked if someone would like to write software to automatically solve this type of problem for the general case, and I accepted and completed that challenge. He hired me to make laser cavities for anti-missile defense systems, but the defense project was then canceled by the sponsor. Through his work on bioglass, Larry knew several professors in the campus hospital, including Ken Anusavice, who was famous for his work on dental materials. When Larry's lab was downsized, he sent me and three other students to Ken, who had enough grant funding to hire over ten students. I found myself in a wonderful environment and stayed there for my BS, MS, and PhD degrees.

Can you share some examples of collaborations or industry partnerships that have been particularly instrumental in your research journey?

It has been small benefits from many different sources. The primary thing has been to never refuse someone who asks for help. Whether it was to serve as a meeting organiser, society officer, grant reviewer, coinvestigator, course director, committee member, or mentor – if someone asked and I had the resources, then I said "yes". This often resulted in working long hours and losing sleep, but it paid back the investment many folds.

Could you explain some key considerations when developing new dental materials?

Developing new materials has not been a major focus for me, but I have been successful in helping others on several occasions when they were out of ideas. In each case, my suggestions did not come from recent discoveries but rather from basic principles that I had encountered in formal courses decades before. My advice to students is to not just study for the exam grade. Learn the basic principles of processing structure properties thoroughly.

In your opinion, what are some of the challenges we face in dental materials science today, and how can the dental community address them?

The interview continues on page 2.

The primary challenge is the disregard of many dental students for materials science. We know that the operator is the most important factor influencing the success (or failure) of dental surgeries. Dental materials researchers should give careful thought to making our research easy to understand and to developing teaching methods that hold dentists' interest and long-term retention of information.

Could you enlighten us on any emerging trends or technologies in dental materials science that you believe will shape the future of dentistry?

We are at the beginning of a new age caused by advances in artificial intelligence (AI). Learning to use AI as a research tool and learning the weaknesses of AI will be important to the career of most dental materials researchers in the future.

You have been utilising some of the latest cutting-edge technologies in your research. How do you stay updated on the latest advancements in dental materials science and related fields?

It is important to make time for traveling and meeting face to face with other scientists. It also helps to agree to serve on panels that review grant applications.

Can you give us a sneak peek into some of your upcoming research projects?

Genetic algorithms (GA) cover for some of the weak points of AI. I am currently repeating some of my previous AI-powered studies using GA. I am also trying to develop a better large-crack fracture toughness test method for ceramics and a new dental implant design that should have greater primary stability in the low-quality bone.

Would you like to share some unique features or characteristics of the Biomedical Materials Science department at UMMC?

My current department has unprecedented levels of trust and transparency. This allows us to provide constructive criticism to each other and to team up in response to external threats more effectively than I have seen before. It is a helpful group of people that is a pleasure to work in.

Lastly, you are an inspiration for all young researchers. What advice would you give to young scientists or students who wish to pursue a career in biomedical materials science?

A successful scientist is one who can adapt to changes in topics and tools. Don't allow yourself to be a 'one-trick pony' but rather be in a state of continuous learning.

About Dr Jason Griggs

Dr Jason Griggs earned his PhD in materials science & engineering from the University of Florida in 1998. He was mentored by Ken Anusavice and Jack Mecholsky. The same year he joined Baylor College of Dentistry as an Assistant Professor and later became a Professor, Graduate Program Director, and Vice-Chair of the Department of Biomaterials Science. In 2007, he moved to the University of Mississippi Medical Center, School of Dentistry as Chair of the Department of Biomedical Materials Science and became Associate Dean for Research a year later. He is a Fellow and former President of the Academy of Dental Materials, with numerous NIH grants, editorial roles, and over 90 peer-reviewed articles, eight book chapters (including those in a core dental materials textbook - Phillip's Science of Dental Materials), and two patents to his name.

Dr Griggs has dedicated his research to two main areas: accelerated lifetime testing of medical materials and devices and analysis of broken surfaces to understand the origins and causes of failures. His expertise spans a wide range of materials and devices, including implant abutments, implant bodies, connector screws, polymer-based denture teeth, polycrystalline ceramics, glass-ceramics, fused layered ceramics, water pipes, and semiconductor wafers. In recent years, he has directed his attention towards design optimization and efficient screening of design factors. He utilises cutting-edge techniques such as response surface methods and artificial intelligence to enhance the research process and improve outcomes.

Dr Griggs was awarded the prestigious Wilmer Souder Award by the International Association for Dental Research (IADR) for his outstanding achievements in dental materials research. This award is one of the highest honors presented by IADR, a prominent international organization that focuses on promoting dental and oral health research. This award is named in honor of Dr. Wilmer Souder, a distinguished figure in the field of dental materials. He is recognized for his significant contributions to the study and advancement of dental materials science throughout his career. The Wilmer Souder Award is typically reserved for individuals who have demonstrated exceptional accomplishments, leadership, and significant contributions to the field of dental materials research.

About Dr Amisha Parekh

Dr Amisha Parekh is currently pursuing her in Biomedical Materials Science at the University of Mississippi Medical Center - School of Dentistry, with an expected completion date in May 2025.

She heads the Dental Biomaterials section of Dental Tribune South Asia. She was also the Assistant Executive Editor of Dental Tribune South Asia (2021-22).

Dr Amisha holds a copyright for her innovation "Dental high-speed handpiece with aerosol control" (Copyright Registration No. L-95018/2020).

Also, her dissertation project: "Titanium (CPTi) implant surfaces with hydroxyapatite and tricalcium phosphate compounds to improve osseointegration" — is currently (as of Oct 2023) under intellectual property review.

Digital Dental Craftsman Convention — huge success

By Dr Rajeev Chitguppi, Dental Tribune South Asia

The Indian Society of Digital Dentistry (ISDD) successfully organized the Digital Dental Craftsman Convention (DDCC) — a unique event where dentists and dental lab technicians came together. With 125 tickets available, the event attracted more than 130 participants—both technicians and doctors — coming from Kerala, Rajasthan, Odisha, Gujarat, Karnataka, Andhra Pradesh, and many other parts of India.

The Digital Dental Craftsman Convention organised by the Indian Society of Digital Dentistry brought the dental technicians and dentists together on one platform. (Image: ISDD)

DDCC—a unique event

DDCC stood out as the first-ever dental lab-focused event that offered dental lab technicians a much-needed platform to discover, learn, and network. The event, held on 21-22 Oct 2023 in Mumbai, distinguished itself by providing practical-oriented sessions for technicians who wish to embrace digital dentistry fully. The event covered all aspects of digital dentistry, including scanning, designing, milling, and printing, which were demonstrated to attendees.

Inauguration

Drs Ratnadeep Jadhav & Pankaj Chivte lighting the lamp.

Inaugural addresses

Dr Vipin Mahurkar, Organizing Chairman, Digital Dental Craftsman Convention 2023.

Zoran Hinic, Head of dental lab at bredent — lighting the lamp.

Dr Pankaj Chivte, President, Indian Society of Digital Dentistry.

Dr Vipin Mahurkar, Zoran Hinic, Dr Ratnadeep Jadhav, Dr Pankaj Chivte.

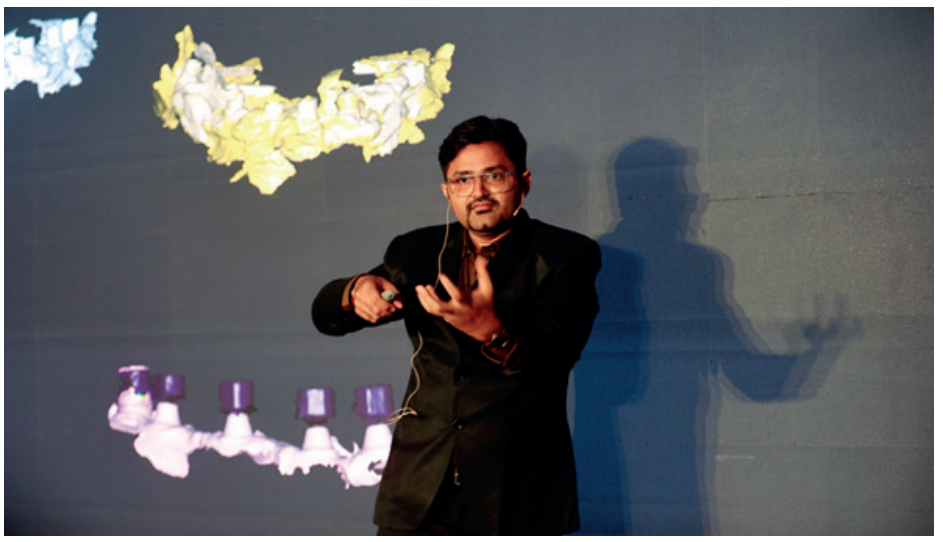
Dr Ratnadeep Jadhav, Secretary, Indian Society of Digital Dentistry.

Keynote lecture: Zoran Hinic, Head of Dental lab at Bredent

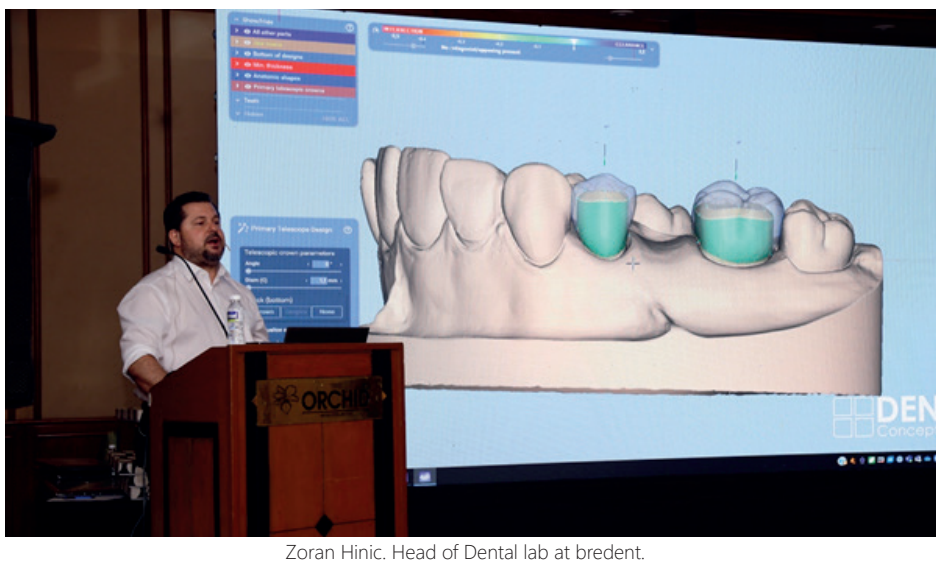
Zoran Hinic. Head of Dental lab at bredent.

Madan Soman speaking on the revolutionary digital denture system 'Ivotion'.

Zoran Hinic. Head of Dental lab at bredent.



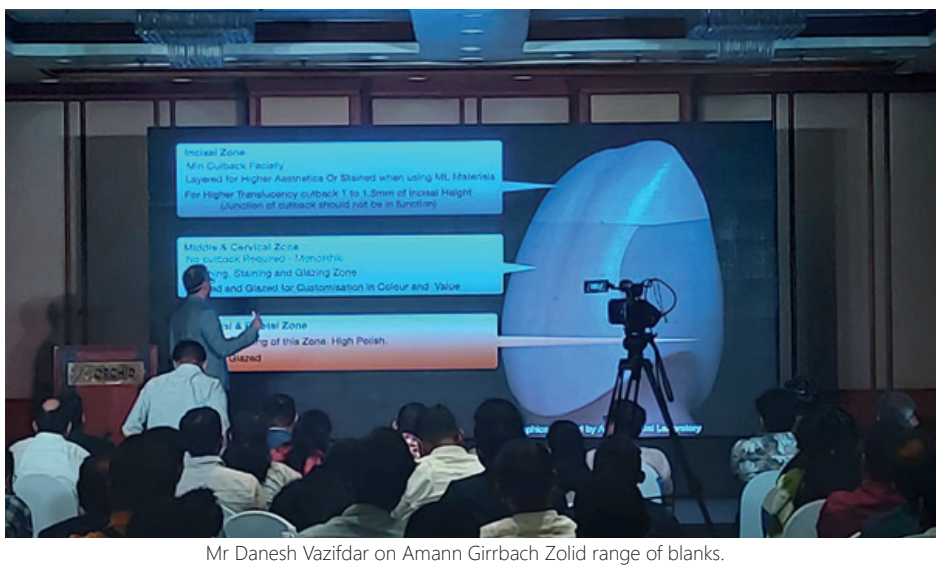
Dr Anshul Mel explaining different options to achieve passive fit in implant prosthetics.



Zoran Hinic. Head of Dental lab at bredent.

Dr Datta Bhajibhakare on conventional vs digital implant prosthodontics.

Keynote Lectures



Mr Danesh Vazifdar on Amann Girrbach Zolid range of blanks.

Dr Prashant Shirke on CBCT for implant planning.

New announcements

Dr. Mahesh Jagwani — printing restorations chairside.

Indian Society of Digital Dentistry panel discussion.

Honorary life membership.

Fellowship in digital dentistry.

Indian Society of Digital Dentistry has many events lined up for the year 2024.

Upcoming events of ISDD

After a highly successful convention in Pune in 2022, attended by more than 800 clinicians with 12 international speakers and 12 industry partners, ISDD plans to hold such conventions bi-annually, with the next event scheduled for November 2024. Furthermore, ISDD will host a digital dental conference for students in Gujarat early next year. ISDD aims to continue fostering the growth and development of digital dentistry in India through these initiatives.

Indian Society of Digital Dentistry:

The advent of digitisation has brought about significant changes globally and has made a substantial impact in India. Digital technology is revolutionising various fields of medicine, including dentistry, where tools like scanners, CBCT, CAD/CAM, 3D printing, and milling are transforming patient care.

To keep pace with this rapid advancement in digital dentistry knowledge and technology in India, the ISDD was officially founded in 2022 by a group of experienced and tech-savvy dentists.

The founding members of ISDD include Drs Ratnadeep Jadhav, Vijay Tamhane, Pankaj Chivate, Sanjay Asnani, Suresh Ludhwani, and Kaustubh Patil.

These founders, who are also multi-practice owners, share a deep passion for digital dentistry and are dedicated to promoting advanced, innovative training in digital dentistry in India, with the aim of enhancing the quality of dental work and creating new opportunities for Indian dentists. Presently, we have been joined by 20 clinicians from various parts of India to expand ISDD's activities to different states.

Prominent endodontist shares expertise on treating patients undergoing radiotherapy

Dr Josiane Almeida will be speaking at ROOTS SUMMIT 2024, which will take place from 9 to 12 May in Athens in Greece. (Image: ROOTS SUMMIT)

By Franziska Beier,
Dental Tribune International

As cancer treatments evolve, clinicians of all disciplines must also adapt their approaches to medical and dental treatments in order to best compensate for the powerful side effects of more robust treatment options. Dr Josiane Almeida, researcher and lecturer in the Department of Endodontics at the University of Southern Santa Catarina and Federal University of Santa Catarina in Brazil, will explain to attendees at the 2024 ROOTS SUMMIT how they can best adapt their approaches for patients who have undergone head and neck radiotherapy.

The number of patients treated with radiation therapy is growing as a result of improvements in surgery and radiotherapy techniques. This means more endodontists will be required to be part of a team providing multidisciplinary treatment. Based on your experience, what should clinicians know about endodontic treatments before and after radiotherapy in order to manage the oral health of a patient?

Head and neck cancer poses a significant health challenge on a global scale. Although radiation therapy is highly recommended for cancer treatment, it may produce adverse effects on the patient's oral condition. The high risk of osteoradionecrosis after radiotherapy limits tooth extraction. Therefore, endodontic treatment is a feasible option for managing oral health. Although an effective root canal treatment avoids serious complications to the patient's oral health, it is necessary to know how to perform it and the ideal moment to choose, taking into consideration all the concerns that arise as a result of irradiation.

What are some of the specific implications of radiotherapy on endodontic treatment? Do endodontists have to change their treatment procedures in order to treat previously irradiated areas?

The dental structure most affected by radiotherapy is dentine, owing to its high organic content. Some of the alterations are caused by a process called radiolysis, leading to dehydration of the substrate, breakdown of the odontoblastic extensions and collagen fibrils, and cracks and fissures around the dentinal tubules. These alterations make the dental structure more susceptible to fracture and increase the dentinal roughness, which in turn affects the interaction between the substrate and microorganisms. Therefore, microbial colonisation, followed by the establishment of a more complex and structured biofilm, may occur. Bearing this in mind, endodontists need to redirect their treatment procedures regarding patients who have undergone radiotherapy in order to achieve endodontic success and restore oral health.

There seems to be a debate about whether root canal therapy or tooth extraction is the preferred option for patients after radiotherapy. From your clinical experience, what is your opinion on this topic?

The ideal course of action for treating a patient who has been exposed to radiation should involve a collaborative effort between medical and dental professionals. The treatment plan should be well thought out, taking into account all potential risks to the patient. It is clear that tooth extraction in radiation-exposed patients may lead to osteonecrosis and other complications that might harm the patient's health. For this reason, endodontic treatment is often the preferred option. Nonetheless, the top priority should always be the patient's overall well-being.

In your presentation, you will speak about future treatment options for patients after radiotherapy. Could you give a preview of what this will entail?

There is limited literature available on the combination of endodontics and radiotherapy. We will not focus on new treatment techniques, as in this sense endodontics itself is already quite advanced, but rather on the damage and structural changes that radiotherapy causes to the dental structures. Additional topics include the way in which such damage can be overcome and the ideal time frame in which to perform endodontics in order to obtain a more effective endodontic treatment with a greater chance of success.

What will be the three main learning objectives of your session at ROOTS SUMMIT 2024?

The objectives will be to address the alterations to dental structures caused by irradiation, to examine irradiation's impact on endodontic therapy and to discuss appropriate treatment approaches for the affected teeth.

What are you personally looking forward to at next year's ROOTS SUMMIT?

The event has been successful since its inception. Although I have never before attended in person, I have followed the entire event—speakers, topics covered and excellent organisation—online. I am excited about participating actively this time in Athens and joining the team of speakers. I am confident that the event will provide valuable knowledge for all attendees, as well as an opportunity to network and share experiences.

Editorial note:

Dr Josiane Almeida will be giving a lecture titled "Effect of radiotherapy on dental structures: Current clinic and future treatment perspectives" at the 2024 ROOTS SUMMIT on 11 May 2024 from 11:00 a.m. to 12:30 p.m.

More information on the programme and registration can be found on the ROOTS SUMMIT website, www.roots-summit.com.

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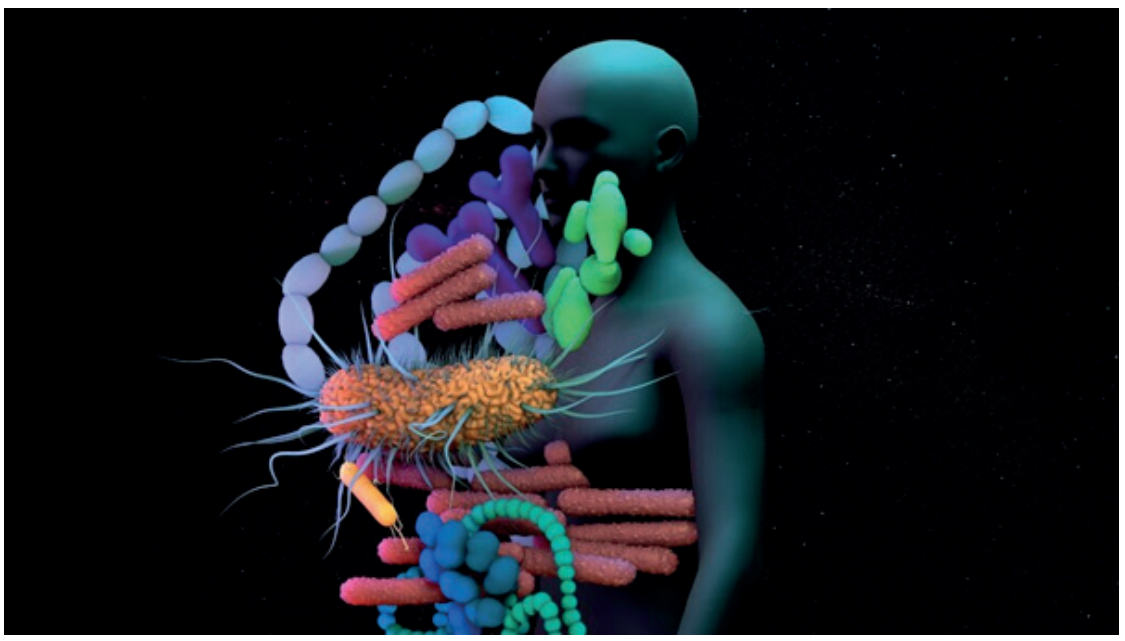
Reversing dysbiosis can treat autoimmune diseases

By Dr Geetpriya Kaur

The human body consists of distinct and abundant microorganisms referred to as the microbiome.[1] The oral cavity is colonized by 700 different species of bacteria.[2] The unique oral microbiome niches are mucosal surfaces, tooth surfaces, and saliva. The gut and oral microbiota are the largest and second-largest microbiota in the human being, respectively.[3] They are physically connected as the oral cavity is the beginning of the digestive tract, thus a large number of oral bacterial species can enter the gastrointestinal tract (GIT) through saliva. The alteration of oral and gut microbiota composition is known as dysbiosis. Recent evidence suggests that oral–gut microbiota dysbiosis plays a crucial role in modulating the initiation and progression of an array of autoimmune diseases. Therefore, targeting and reversing oral–gut microbiota dysbiosis can be an effective strategy for treating autoimmune diseases.[1,4]



Recent evidence shows that targeting and reversing oral–gut microbiota dysbiosis can be an effective strategy for treating autoimmune diseases. (Image: Canva)

Oral microbiota targeted therapy

To prevent autoimmune diseases, it is important to maintain homeostasis dynamics between the oral microbiota, gut microbiota, and the host immune system. The driving factors that significantly affect the composition and structure of the oral microbial flora are poor oral hygiene, smoking, dietary shifts such as high carbohydrate, fat, and sugar intake, administration of antibiotics, and infections.[1] The main potential strategies for treating oral microbiota-mediated autoimmune diseases are:

Good oral hygiene

Oral infections such as dental caries and periodontitis upregulate several systemic inflammatory reactions which, in turn, play a crucial role in the initiation and development of many autoimmune diseases. Thus, maintaining oral hygiene can prevent autoimmune diseases.[5]

Low carbohydrate, sugar, and fat diet

These dietary changes can reduce the oral microbial load, thereby affecting the composition of the oral microbial communities.

Healthy lifestyle

Lifestyle changes including proper sleep, stress reduction, and physical exercise can improve the condition of patients suffering from autoimmune diseases.

Usage of prebiotics, probiotics, or synbiotics

Probiotics are foods or supplements that contain live microorganisms intended to maintain or improve normal microflora. Prebiotics are typically high-fiber foods that promote the production of beneficial microbial metabolites for pathogenic bacteria suppression and improvement of the gut barrier.[1] For instance, Prebiotic D-tagatose suppresses the growth of the oral pathogens *Streptococcus mutans (S. mutans)* and *S. gordonii*.[1] Synbiotics are mixtures of both probiotics and prebiotics that improve the activity and survival of beneficial gut microflora.

Oral microbiota transplantation (OMT)

Huang et al. suggested that OMT can be a promising strategy for the treatment of autoimmune diseases. Oral bacteria can be efficiently encapsulated for curing oral microbiota-mediated autoimmune diseases. A recent study demonstrated that OMT alleviated radiotherapy-induced oral mucositis by altering the oral microbiota composition in mice.[1]

Nanomedicine–based therapeutics

The nanomedicine–based strategies involve biological immunomodulatory agents for the treatment of autoimmune diseases such as Inflammatory bowel disease (IBD), psoriasis, rheumatoid arthritis (RA), systemic lupus erythematosus (SLE), multiple sclerosis (MS), and Type 1 diabetes (T1D). For instance, TNF – α siRNA nanomedicine-targeted macrophages can significantly reduce TNF – α levels to improve the condition of patients suffering from IBD1.

Gut microbiota targeted therapies

The composition and function of the gut microbiota are generally altered in patients with autoimmune disorders.[4] The major potential strategies for curing gut microflora-mediated autoimmune diseases are:

Fasting-mimicking diet (FMD)

The FMD consists of specific plant-based ingredients such as low carbohydrates, proteins, and good fatty acids that keep the patient in a fasting state. This diet protects the body by rejuvenating the cells and improving their functions, thus reducing intestinal inflammation.[4]

Water–only fasting intervention

This intervention can enhance the body's regenerative mechanisms and also reduce inflammatory markers.[4]

Probiotics and prebiotics

Probiotics might be used as an adjuvant therapy to maintain the homeostasis of the gut microbiota and can affect systemic immune responses. Prebiotics support numerous digestive and immune functions.[4]

Fecal microbiota transplantation (FMT)

FMT is an effective therapeutic modality that can alter the composition of the gut microbiome in clinical settings. The process involves transferring the gut microbiota from a healthy donor, already screened for pathogens or any underlying disorder to a recipient through various modes like oral capsules, enemas, or transnasal intestinal tube infusion of bacterial fluids. Thus, it provides colonization resistance, produces favorable metabolites, and restores mucosal immune system interactions while improving the symptoms of the patient. Several clinical trials have been conducted to study the effects of FMT in different autoimmune diseases.[6]

FMT and RA

A recent study on RA patients treated with FMT revealed that FMT can alleviate the symptoms of RA. On the 42nd day after FMT, the Health Assessment Questionnaire Disability Index (HAQ-DI) dropped to 0.05, the Disease Activity Score 28 (DAS28) was 1.9 from the initial score of 6.6, and the titer of the rheumatoid factor decreased to 158 from the initial value of 314 IU/ml.[7]

FMT and MS

The latest study conducted on nine patients with MS who were treated with monthly FMTs for six months disclosed that the patients with abnormal intestinal permeability improved to the normal range. Additionally, the concentration of Hungatella hathewayi spp. also increased post – FMT, thus suggesting the efficiency of FMT in modifying the gut microbiome composition.[8]

FMT and IBD

In 2014, a meta-analysis of 122 patients revealed a potential impact of FMT in different types of IBD; pooled results from 18 studies showed a clinical remission of 36.2% and 60.5% in Ulcerative colitis (UC) and Crohn's disease (CD) patients, respectively. Another clinical trial named Fecal Microbiota Transplantation in Ulcerative Colitis (FOCUS) on 85 active UC patients, evaluated the clinical and endoscopic remissions while comparing FMT by colonoscopy, FMT enema, and a placebo for eight weeks. A remission rate of 27% was observed in the FMT group while 8% remission was observed in the placebo groups.[9]

Conclusion

The oral and gut microbiota dysbiosis plays a critical role in the initiation and progression of several autoimmune diseases, thus targeting oral and gut microbes can be a potential strategy for curing autoimmune conditions. The current approaches including dietary changes, probiotics, prebiotics, and FMT have improved the condition of patients suffering from autoimmune diseases. Further clinical trials are needed to study the effect of OMT and FMT therapies on autoimmune diseases.

References

Available upon request

About

Dr Geetpriya Kaur is an oral pathologist, running a dental diagnostic center for the past nine years. She taught oral pathology courses as a professor at the Department of Oral Pathology and Microbiology at the Institute of Dental Studies and Technologies (IDST), India. She has also worked as an assistant editor with the *Journal of Clinical and Diagnostic Research* and has many national and international publications to her credit. Additionally, she has peer–reviewed articles in national and international journals.

Her master's thesis looked into "Detection of oral squamous cell carcinoma metastasis with cathepsin D: An immunohistochemical study" and concluded that patients with lymph node metastasis had higher Cathepsin D(CD) expression and that increasing tumor size seemed to correlate with higher CD expression. Thus, based on the active potential of CD in regulating the prognosis of oral squamous cell carcinoma (OSCC), the design and synthesis of specific CD inhibitors can have significant research and therapeutic consequences.

Combined treatment potentiates anti-biofilm and anti-cariogenic efficacy

By Iveta Ramonaite,
Dental Tribune International

Researchers have recently combined two treatments for dental caries, thus enhancing their antimicrobial potency. (Image: Andrey_Popov/Shutterstock)

PHILADELPHIA, US: According to research, dental caries is the most prevalent and costly biofilm-induced oral disease. Fluoride as the primary anti-cariogenic agent cannot both sufficiently control biofilm and prevent enamel demineralisation and can lead to risks associated with overexposure to fluoride, especially in children. However, a recent study has shown that using a combination of an iron oxide nanoparticle (ferumoxytol, Fer) approved by the US Food and Drug Administration and stannous fluoride (SnF2), even at lower concentrations, can help inhibit both biofilm accumulation and enamel damage. The study has the potential to prevent dental caries and to reduce fluoride exposure in patients.

"Traditional treatments often come short in managing the complex biofilm environment in the mouth," senior researcher Dr Hyun (Michel) Koo, a co-founding director of the Center for Innovation and Precision Dentistry and a professor in the Department of Orthodontics at the University of Pennsylvania, said in a press release. "Our combined treatment not only amplifies the effectiveness of each agent but does so with a lower dosage, hinting at a potentially revolutionary method for caries prevention in high-risk individuals," he continued.

The researchers found that Fer can stabilise SnF_2 and that it shows increased catalytic activity when combined with SnF_2. Additionally, they discovered that fluoride, iron and tin form a protective film on tooth enamel to protect it against further demineralisation. It was also reported that the combined therapy did not disrupt the ecological balance of the oral microbiota and showed no side effects on the surrounding host tissue.

Senior author Dr David Cormode, an associate professor of radiology at the university, commented: "What excites us most about these findings is the multifaceted approach to caries prevention. It's not just about inhibiting bacterial growth or protecting the enamel; it's a holistic method that targets both the biological and physicochemical aspects of dental caries."

"While we are happy with these initial findings, we still aim to dig deeper in understanding the intricate ways Fer and SnF_2 synergise to boost the therapeutic effects," Dr Koo added.

Since both Fer and SnF_2 are commercially available, the research findings could quickly be translated into clinical practice. However, further research is needed to closely examine the mechanisms of interaction between SnF_2 and Fer, the process of reactive oxygen species generation and the formation and efficacy of the protective enamel film. "There's potential here not just in dental care but in exploring how this combination can be targeted against other biofilms," Dr Cormode said.

The study, titled "Iron oxide nanozymes stabilize stannous fluoride for targeted biofilm killing and synergistic oral disease prevention", was published online on 29 September 2023 in *Nature Communications*.

How machine learning is transforming dentistry

By Dr Rewant Chauhan

The past few decades have witnessed remarkable progress in the application of artificial intelligence (AI) and machine learning (ML) in medicine, notably in medical imaging. The application of ML to dental and oral imaging has also been developed, powered by the availability of clinical dental images. As ML models become more adaptive day by day, there is a huge scope for further enhancement of these tools and their application in dentistry.

As the machine learning (ML) technology continues to develop, we can expect to see even more innovative applications of ML in dentistry. (Image: Canva)

ML, as a branch of AI, empowers computers to learn and make decisions from data without being explicitly programmed. It's like teaching a computer to recognize patterns or trends. Instead of providing rigid instructions, you feed the machine a lot of information, and it figures out how to solve problems or make predictions on its own. For instance, it can identify objects in photos, predict stock market trends, or recommend movies based on your preferences. Machine Learning is all about computers learning from data to assist us in solving complex problems and making smarter decisions.

ML, the ever-evolving domain of AI, has, in recent years, become synonymous with innovation across various industries. It is the digital guardian behind self-driving cars, the curator of personalized playlists, and the diagnostic powerhouse in healthcare. But in the realm of dentistry, its remarkable potential to revolutionize oral care has remained relatively uncharted territory.

Applications currently available in the dental industry:

- **V7:** A computer vision platform that allows dentists to build and deploy AI solutions for dental imaging, such as dental decay and periodontal disease detection, oral cancer detection, endodontics, and orthodontic treatment planning.
- **Dentem:** A cloud-based dental practice management software that uses ML to automate tasks such as appointment scheduling, billing, patient communication, and analytics.
- **Denti.AI:** A dental image analysis software that uses ML to detect and diagnose dental caries, periodontal diseases, bone loss, and other oral conditions.
- **Pearl:** A dental AI company that offers various products such as Smart Margin (a margin marking software for dental restorations), Smart Radiology (a radiograph interpretation software), and Smart Triage (a teledentistry software).
- **Overjet:** A dental AI company that provides products such as Overjet Vision (a dental charting software), Overjet Clinical Review (a dental claims review software), and Overjet Research Platform (a dental research software). The accuracy of ML software depends on various factors, such as the quality and quantity of the data used to train and test the ML models, the choice and complexity of the ML algorithms, the performance metrics and evaluation methods, and the clinical relevance and applicability of the results.

Accuracy rates:

Some of these software have reported high accuracy rates for different tasks and domains in dentistry. For example:

- V7 claims to achieve an accuracy of 99.7% for dental decay detection, 98.9% for periodontal disease detection, and 97.8% for oral cancer detection.
- Dentem claims to reduce human errors by 80% and increase productivity by 30%.
- Denti.AI claims to achieve an accuracy of 95.4% for dental caries detection, 94.2% for periodontal disease detection, and 92.6% for bone loss detection.
- Pearl claims to achieve an accuracy of 97% for margin marking, 96% for radiograph interpretation, and 95% for tele dentistry.
- Overjet claims to achieve an accuracy of 98% for dental charting, 97% for dental claims review, and 96% for dental research.

However, these accuracy rates may not reflect the true performance of these software in real-world settings, as they may be based on limited or biased data or use inappropriate or inconsistent metrics. Moreover, accuracy is not the only criterion to evaluate the usefulness of ML software, as other factors such as reliability, validity, interpretability, generalizability, usability, and cost-effectiveness should also be considered.

Therefore, it is important to critically appraise the evidence and claims of these softwares before adopting them in clinical practice. More rigorous and standardized research is needed to validate and compare these software and their ML models. Ethical and legal issues such as data privacy, consent, liability, and accountability should also be addressed.

Limitations:

Some of the limitations of ML software are:

- They may not be able to handle complex or rare cases that require human expertise and judgment, such as interdisciplinary or ethical issues.
- They may not be able to explain their reasoning or decisions, which can affect the trust and acceptance of the users and patients.
- They may not be able to generalize to different settings or populations, such as different dental systems, cultures, or demographics.
- They may not be able to cope with the dynamic and evolving nature of dentistry, such as new technologies, techniques, or standards.
- They may pose ethical, legal, and social challenges, such as data privacy, consent, liability, and accountability.

The use of ML in dentistry is still in its early stages, but it has the potential to revolutionize the way that dental care is delivered. ML models can help dentists to make more accurate diagnoses, provide more personalized treatment plans, and improve patient outcomes.

Other applications:

ML is also being investigated for use in a variety of other areas of dentistry, such as:

- **Drug discovery and development:** ML can be used to identify new drug targets and to design and develop new drugs for the treatment of dental diseases.
- **Predictive analytics:** ML can be used to predict the risk of developing dental diseases, such as caries and periodontal disease. This information can be used to develop personalized prevention strategies.
- **Clinical decision support:** ML can be used to develop clinical decision support systems that can help dentists to make more informed treatment decisions.
- **Quality improvement:** ML can be used to monitor the quality of dental care and to identify areas where improvements can be made.

Challenges:

- One of the key challenges in the development of ML models for dentistry is the need for large and high-quality datasets. Dental data is often difficult to collect and can be subject to a variety of biases. As a result, it is important to carefully consider the data collection process when developing ML models for dentistry.
- Another challenge is the need to ensure that ML models are explainable and interpretable. Dentists need to understand how ML models make decisions to trust them. As a result, it is important to develop ML models that are transparent and can be easily explained to dentists.

Conclusion

The future of ML in dentistry is bright. ML has the potential to transform the way dental care is delivered and to improve the lives of patients worldwide. As ML technology continues to develop, we can expect to see even more innovative applications of ML in dentistry.

About

Dr Rewant Chauhan is a dental professional with a passion for using technology to improve the practice of dentistry. He has a strong analytical mind and a knack for problem-solving, which he brings to his work as an independent dentist and healthcare innovator. He is particularly interested in using artificial intelligence and machine learning in dentistry. He believes that these technologies have the potential to revolutionize the way dental professionals diagnose and treat patients. To this end, he has been involved in healthcare initiatives that explore the use of AI and machine learning in dentistry.

Also, Dr Rewant is well-versed in a variety of computer platforms and advanced software packages that can assist dental practitioners. He has experience in digital dentistry workflows and CAD/CAM software, which he uses to improve the accuracy and efficiency of dental treatments.

Dr Rewant Chauhan's contributions to the field of dentistry include a patent for an AI model in dentistry. This innovation has the potential to enhance the precision and effectiveness of dental treatments, which could lead to better patient outcomes.

Overall, Dr Rewant Chauhan is a dental professional with a passion for using technology to improve the practice of dentistry. His expertise in AI and machine learning and his experience in digital dentistry workflows make him a valuable contributor to the field.