

CUTTING-EDGE INNOVATIONS TO IMPROVE DENTAL PRACTICE

Here come the innovators
Companies that are leading
the way in innovation

**Technique: How to streamline
cementation of crowns**

**PRODUCT ROUNDUP:
3D printers**

The innovation that's changed my practice



DR. BROOKE BLICHER

New technology is always exciting, but its introduction is rarely without worry. Dental technology is expensive,

and its installation can be disruptive not only in the physical sense, but also in its incorporation into well-established routines and processes. Taking the leap to invest in an expensive piece of equipment can intimidate even the most experienced provider.

CBCT technology was the talk of the endodontics world in the early part of this decade. Manufacturers advertised in all the journals and were major sponsors at the AAE Annual Session. Residency programs around the country were installing machines, and talk was that CBCT imaging would become standard of care in endodontics practice. I read the literature, went to lectures and chatted frequently with students and colleagues on the indications for using CBCT technology.

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THE SCI-FI OF FUTURE DENTISTRY

How technological advances will impact the dental industry.

by Annemarie Mannion; additional reporting by Lauren Krzyzostaniak

Not since the development of composites in the 1960s and the introduction of CAD/CAM in the 1980s has there been such an exciting time of innovation in dentistry. Researchers, manufacturers, scientists and practitioners are welcoming new and emerging technologies, from 3D printing and self-healing teeth to non-chemical disinfectants and digital scanning — all of which have the potential to transform in meaningful ways how dentistry is practiced.

Call it the true science fiction of future dentistry. These new technologies are the wave of the future. They will not only change the way dentistry is performed and how dental practices are operated day to day but will dramatically improve outcomes for patients.

“These new technologies are all about how to best interact with and treat the patient,” says Dr. Lou Shuman, founder and CEO of Cellerant Consulting Group, an incubator and accelerator for companies creating new dental technologies. “Instead of having to focus on all of the other aspects of running a practice, the dentist can automate certain tasks and concentrate on patient care. That’s what drives what we do at Cellerant; getting these companies and technologies out in the market in order

to simplify the workflow and optimize the capabilities of the dental practice.”

Because technology and innovation is the focus at Cellerant, many of their clients are leading the way in voice-activated technologies, automated practice management and marketing software, artificial intelligence and machine learning in caries detection, antibiobacterial restoratives and chemical-free water disinfection, to name a few. ... See *science fiction*, page 44





THE TRUE SCIENCE FICTION OF FUTURE DENTISTRY

Exploring the future of cutting-edge technology and what it will mean for the dental industry. [by Annemarie Mannion with additional reporting by Lauren Krzyzostaniak]

FROM ADVANCES IN ARTIFICIAL INTELLIGENCE TO THE DEVELOPMENT OF ANTIMICROBIAL RESTORATIVES, TECHNOLOGY IS SHAPING THE FUTURE OF THE DENTAL INDUSTRY. WHILE THESE TECHNOLOGICAL ADVANCES MAY SEEM LIKE SCIENCE FICTION, THEIR PRACTICAL APPLICATION CAN LEAD TO IMPROVED PATIENT OUTCOMES AND STREAMLINED WORKFLOWS.

continued from cover ...“Some of those new technologies utilize artificial intelligence and machine learning to make things easier for both dental professionals and patients alike,” Dr. Shuman says. “Others are focused on improving the materials used in the dental practice by either making them last longer or take on a more active role in the oral environment.”

Composite advances

When dental composites were developed by Dr. Ray Bowen nearly 60 years ago, they were a welcome alternative to the amalgam that had been used for more than 150 years to fill cavities. Amalgam leaves a lot to be desired. Made up a mixture of silver, mercury, tin and other metals, it has been found to contribute to higher mercury levels in patients’ blood, making finding alternatives to traditional amalgam fillings increasingly important. Esthetics are also a big concern for patients, especially since a study found that 90 percent of adults have at least one dental filling, and the average number of fillings per person is seven.¹

Dr. Jeffrey Kim, project leader at the ADA Foundation Volpe Research Center, is working with researchers to look for ways to improve composites and make them last longer. “Despite our numerous advances with composites, I think dentists are always looking for better dental materials,” Dr. Kim says.

Researchers are also working on the development of composites with self-healing properties that would actually promote regeneration and healing in the affected tooth as well as increase restoration longevity. Dr. Kim is in year four of a five-year study funded by the National Institutes of

Health that looks at how to improve treatment of Class V lesions to promote self-healing.

“This is a really exciting time,” Dr. Kim says. “We’re changing the chemical properties of the traditional composite to a new composite that can better adapt to the Class V lesion. Since they’re right next to the gum and moisture control is a problem, they can be challenging. The new composite will address those issues. In addition, the composite will promote healing. If there are micro cracks, it can heal those tiny cracks, so the tooth doesn’t become a failure.”

Innovations in these dental materials of the future will also mean being able to target a composite to a particular type of caries. Dr. Kim is currently submitting patents for his new composite technology and foresees companies picking up on his research and running with it to develop new products.

Bioactive materials have been a big part of the conversation about the future of dentistry for a while. Researchers and dentists know that traditional hydrophobic materials will likely be phased out in the future and replaced with something that can actually interact with the living tissues around it.

“Bioactive materials have the potential to solve the leading cause of failure in restorations and cementation: microleakage,” says Larry Berk, director of clinical affairs and marketing at Pulpdent. “Current resin technologies tend to be hydrophobic and passive in the moist oral environment. Hydrophobic materials do not allow for ion exchange with the tooth structure and can result in microleakage.”

There’s now a focus on bioactive resin materials, which are hydro-

philic and contain minerals that can interact with the tooth structure, helping to create a seal and prevent microleakage. While these materials are already available on the market, the future will offer more in terms of application and delivery.

“You will begin to see bioactive products addressing white spot lesions in orthodontics, better coronal seals in endodontics and more,” Berk says. “Researchers will continue to find new applications for bioactive materials, from prevention and orthodontics to endodontics, restorative dentistry, bone cements, implants and materials that stimulate tissue regeneration. The ultimate goal of these advances will be to improve patient outcomes with less invasive procedures whenever possible.”

Antimicrobial restoratives

Because secondary caries is the primary cause of failures of composite restorations, researchers have also been looking into developing restoratives that are bacteria-resistant.

One company on the forefront of this technology is Israel-based Nobio, which developed a line of dental restoratives that contain silica dioxide filler with quaternary ammonium (QA) residues that are covalently bonded to the surface. This is intended to reduce the number of bacteria that may remain in the cavity.

“The idea was that none of the existing dental materials had any long-lasting anti-bacterial properties,” says Dr. Ervin Weiss, dean of the Goldschleger School of Dental Medicine at Tel Aviv University and chief technology officer at Nobio. Weiss and other scientists from the Hebrew University of Jerusalem and Hadassah Medical Center first came up with the idea to develop anti-bacterial restoratives 10 years ago.

The idea was to create a composite with an antibacterial component that wouldn’t degrade or leak into the surrounding area, which is what they’ve created in the final product.

Nobio has designed a line of light-cured restoratives, including a universal bonding agent, a flowable

“We have the beginning of a new class of materials. We’re on the verge of an era when we can go into the oral cavity with materials to address the major etiologies of diseases.”

composite, a bulk fill flowable composite and a universal composite. All of these contain the QA filler intended to reduce the number of bacteria that may remain in the cavity and to maintain the functionality and integrity of the restoration.

Weiss says the materials have been laboratory tested and shown to reduce bacteria dramatically. While the technology has applications outside of dentistry (such as for catheters or joint replacements), it has the potential to be a game changer for dentistry.

“The potential is tremendous to be incorporated into nearly every single type of dental material on the market today,” Weiss says. “We have the beginning of a new class of materials. We’re on the verge of an era when we can go into the oral cavity with materials to address the major etiologies of diseases.”

Dentists will not require additional training to use the company’s products, says Yoram Ashery, CEO of Nobio. He says the company has prioritized incorporating the disease-fighting agents at production. “Our whole approach is to keep every aspect of the procedure in the dentist’s office as is,” he says.

While Nobio will soon seek clearance for its products from the FDA, researchers from the University of Toronto have also been exploring antibacterial filling materials.² Utilizing mesoporous silica, a recent

development in nanotechnology, the team was able to create a filling that self-assembled the antimicrobial drug octenidine dihydrochloride (OCT). The combination of silica glass and drugs maximized the drug's density; it can pack over 50 times the amount into the material compared to others, allowing OCT to slowly diffuse over the course of years. It's also important to note that OCT is an effective broad-spectrum antibiotic that has no known formation of resistance.

The Toronto team's next goal is to perform in vivo testing of its new material to observe how the harsh environment of saliva and bacteria will affect it.

Caries prevention

While composite advances target the restoration of existing problems, other companies are looking to prevent them altogether with sealants to strengthen enamel and add an extra line of defense against acid and bacteria.

Premier Dental's BioCoat is an example of such a product. "The technology is novel," says Dr. Jason Goodchild, director of clinical affairs at Premier Dental. "It can help protect and repair. It's the building block of other new products."

BioCoat, a sealant that features trademarked SmartCap Technology, was developed in partnership with Creighton University. The product utilizes patented semi-permeable resin microcapsules filled with fluoride, calcium and phosphate, which diffuse in and out of the sealant. Goodchild says studies have shown that even at six months, ion release continues at a significant rate. BioCoat also strengthens enamel and seals margins against microleakage to provide an extra line of defense during acid attacks.

Tooth regeneration

While still in its infancy, recent stem cell research recently posited that regrowing teeth may soon be possible.³ Using embryonic tooth germ cells, researchers at Okayama University in Japan have recon-

structed bioengineered tooth germ with a technique known as the organ germ method, a 3D cell manipulation technique.

According to the study, micro-CT analysis showed that the developmental process of the bioengineered tooth's formation was practically identical to that of a natural tooth.

The researchers at Okayama University noted that immature wisdom tooth germ may be considered a potential candidate for reconstruction of bioengineered tooth germ.

However, there are some limitations. For instance, elderly patients don't have developing tooth germ that could be used for this process. Autologous transplantation of tooth germ is also limited by the number of available teeth and the size of a given tooth.

In the end, the researchers concluded that additional evidence and testing will be required for the medical application of this process — but new developments could be coming down the road soon, which could have very interesting implications for the future roles and responsibilities of dentists.

Infection control

Another area in which breakthrough technology is poised to spark revolutionary change in dentistry is infection control, particularly water disinfection. Dental unit waterlines provide the ideal environment for the growth of bacteria and biofilm, requiring dental practices to use a variety of chemicals, masks, cleaning procedures, distilled water and other practices to keep bacteria from harming both patients and staff.

Toppen Dental is one company taking the lead in dental unit waterline treatment. Toppen offers an inline water filter called QDFx, which utilizes quantum disinfection technology to destroy bacteria and viruses in municipal tap water without adding chemicals.

"It's like a battery that puts out enough positive charge to destroy bacteria on contact," says Owen

The question isn't where voice technology will be, but where it won't be. Just imagine where this can go. Why should I ever have to touch another piece of technology again to move a chair up or down or to play music or a TV show for a patient?"

Boyd, Toppen's chief technical officer who has 25 years of water treatment experience.

Unlike chemical approaches to water disinfection, such as silver, chlorine or iodine, which take from 30 to 90 minutes to kill bacteria, Toppen's product kills bacteria on contact. Boyd explains that QDFx also is useful because it doesn't promote the emergence of superbugs, as chemical applications can.

"Bacteria are pretty smart," he says. "They don't like to be killed. They change their DNA to become resistant to the chemistries that are trying to kill them."

The company is also harnessing one of nature's most potent natural disinfectants: ozone. Boyd notes that ozone is about 50 times more powerful than chlorine and kills bacteria and viruses three times as quickly, which results in superior disinfection response with very low concentrations.

The company produces an ozone spray bottle for surface disinfection, as well as a range of other products that can help prevent ill health effects from using chemical cleaning products. Boyd says dentists need to

become aware of the dangers of using harsh products multiple times a day.

"If you're using household cleaners every day, that's the impact of smoking a pack of cigarettes a day," he says. "This is a commonsense approach for the office environment. No more, 'Let's clean the office but leave behind the hazardous materials that could cause potential health problems.'"

Al Dube, president and CEO of Toppen, says the company is committed to making dental practices safer by reducing the use of chemicals. "This is a mission to transform the thought process of dentistry," he says.

3D printing

Technology is moving ahead for dental laboratories as well. Arfona is working on the next generation of 3D printing for dental labs with rPod, a desktop 3D printer that's versatile enough to digitize a lab.

"Our approach is to take dental materials that have stood the test of time and to provide them in a format suitable for additive manufacturing," says Justin Marks, president of Master-Touch Dental Lab and CEO of Arfona.

Marks predicts dental labs will put their old injection systems aside as they make the switch to 3D printing to optimize their workflow.

"You'll be able to do more units and at less cost," he says. "They'll see faster turnaround, especially if they're using intraoral scanners. It can be done in half the time than what's done in traditional practice."

He adds that the potential benefits of 3D printing are enormous for patients.

"When [3D printing] becomes widespread, it will have the potential to bring costs down and reach people who aren't replacing teeth," Marks says.

Younger dentists have already been introduced to 3D printing during dental school or residency.

"[During my residency], they brought in this 3D printer and showed us the software, the steps and the workflow to build a model from

a scan,” says DPR Editorial Advisory Board member Tera Poole, who will graduate in June from a residency in orthodontics at the University of California, San Francisco.

When she goes into private practice, Poole expects to eventually have a 3D printer in her office. She believes being able to create aligners, crowns and other prosthetic devices quickly and on demand will be an expectation of dentists and orthodontists of the future.

“For my generation and the one after me, it’s how we’ve grown up,” Poole says. “We’ve grown up in a technological world. We definitely like convenience and the on-demand aspect.”

Practice marketing

Reaching existing and new patients remains a large concern for dentists — especially in the unknown landscape of an increasingly digital world. To stay on the forefront of the digital revolution, dentists need to be savvy about their web presence and online marketing tactics or risk getting left behind. As marketing and practice management tools go online, automation will become the name of the game, streamlining processes and saving front office staff a lot of time and energy.

What does this mean exactly? Think everything from voice-activated practice management systems to wearables to complete automation of patient reminders and marketing.

Several companies are already developing new technology and solutions to help dentists stay ahead of the curve. For example, MMG Fusion is focused on helping dentists grow their practices and their brand. Their system is an all-in-one practice marketing tool that manages a practice’s brand and optimizes visibility on various online platforms, including social media, local directories and search engines, and websites. It also addresses other critical aspects of practice management such as patient reminders, call conversion, online scheduling, marketing budgets and decisions.

“This is the only system that has integrated all of those tasks into one product,” says Paul Intlekofer, CEO of MMG Fusion. “More importantly, our new ChairFill product automatically optimizes your schedule to maximize growth.”

ChairFill mines existing patient records and tracks the practice’s ROI for new patient acquisition, automatically monitoring how well the practice is increasing case acceptance and using that information to identify how much to spend on new patient acquisition. But even that step is automated. If the practice chooses, the MMG growth system can make those marketing decisions and take the appropriate marketing action on behalf of the practice, such as modifying your SEO spend when your internal ChairFill campaigns are filling your schedule.

Practice workflows

An efficient workflow is also critical for practice success. Patients in a digital world will want to see new technology and gadgets — and the benefits gadgets have of getting patients out of the chair quicker. One simple way to streamline clinical workflows is through the use of smartphones and smartwatches.

Simplifeye is taking advantage of this technology to make the dental practice workflow seamless. Founded by Ryan and Zach Hungate, HIPAA-compliant Simplifeye is a technology that allows dentists and dental team members to view patient information on an Apple Watch.

The watch shows a quick overview of the current workflow, color-coding patient records on the watch face and detailing who the patient is, when their last appointment was, what services are needed, and — most importantly — what health conditions the dentist should know about. That allows dentists to utilize their time more effectively.

Simplifeye also allows the incorporation of voice technology, which Ryan Hungate, DDS, predicts will be a huge time saver for dentists. Instead of putting down a drill and

removing gloves just to review an image, the dentist can complete the task with a simple voice command.

“You don’t have to take your gloves off at all,” he says. “You can tilt your wrist toward you and say, ‘Show me the last panoramic X-ray.’ Because the technology is smart, we know which screen you are standing closest to and it will actually throw the image to that screen.”

The Hungates think voice-command technology is the wave of the future in dental practices and elsewhere. “One of the things dentists do every single day is look at images. Going forward, it should always be hands-free,” Zach Hungate says.

But it doesn’t end there.

“The question isn’t where voice technology will be, but where it won’t be,” Ryan says. “Just imagine where this can go. Why should I ever have to touch another piece of technology again to move a chair up or down or to play music or a TV show for a patient?”

Artificial intelligence

The conversation about future tech in dentistry often ventures into the realm of artificial intelligence at some point. It’s already in medicine, so why not dentistry? IBM’s Watson is already using deep learning in cancer research, but Watson hasn’t donned a dental cap yet.

However, there’s a deep-learning AI platform for detecting caries that’s in the late stages of clinical evaluation. Dentistry.AI already demonstrates sensitivity and precision when analyzing bitewings and may be available in the next year or two. Where this could go in the future is limitless, from detecting periodontal disease and bone loss to predicting tooth movement and detecting oral cancer earlier than ever before.

What does it all mean?

The experts agree that this era of new technology holds great promise for the dental industry. Whether the technology improves business efficiency or better protects patients’

teeth, practitioners are looking forward to incorporating these intriguing technologies into their practices.

“There are many other areas where research is occurring that hold huge promise for transforming dentistry,” Dr. Kim says. For instance, researchers are developing a milling process that uses a powdered dental material with disease-fighting additives incorporated into it before it’s cured into a solid product. Other projects in the works include a technology that would allow practitioners to affix oral bio-sensors to a bridge or crown, allowing them to monitor the health within the oral cavity.

Since change is occurring at such a fast pace, Dr. Kim says dentists are well-advised to keep track of new developments by doing their homework and getting involved in local dental societies.

“I think you can do it best by getting involved with your local dental society and by taking quality continuing education classes,” he says.

Experts like Dr. Kim and the Hungates predict the technology of the future will improve patient outcomes, make practices more efficient, and save dentists time and money. It may also lead to dentists who feel more fulfilled in their work and are less stressed.

“I think new technologies will help dentists make more money, so they can go home and hang out with their families,” Zach Hungate says. As workflows become automated and materials take on larger roles, the work-life balance of dental professionals should increase. And that would mean a better world for everyone involved.

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