The Digital Revolution's Impact on Prosthodontics

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In a global market there are three ways to approach change:
you can fight it and fail, you can accept it and survive, or you can lead it and prosper.

—Michael O. Levitt, US Department of Health and Human Services

Virtually all of our current clinical and technical prosthodontic procedures can be supported or realized by new digital technologies. As the majority of clinicians and technologists move to digital processes and procedures, communication among the dental team (dentist, dental technician, dental hygienist, and patient) and the prosthodontic procedures themselves will drastically change, becoming faster and more efficient.[1] More people will then be able to request treatment, more patient-adequate solutions and patient-centered care will be available, and more personalized dentistry will happen.[2] These predictions may sound exaggerated, but technical developments at the sharp end suggest that we are already there. This editorial addresses some challenges at the levels of clinical and personal patient management, dental technology, and education.

Medicine and dentistry have changed dramatically over the years and will continue to do so. A good example in our field is the use of implants, which in the beginning offered predictably successful treatment mainly for edentulous patients. Today they are used with proven success for every clinical situation. As a positive consequence, aging patients profit from shorter and less invasive implant surgery—even elderly risk patients may qualify for complex implant treatment. For the latter, full treatment planning can be performed in a digital environment.[3] These changes are linked to general technical progress and the fourth industrial revolution (digital transformation), changes in the dental practice, and demographic shifts such as aging and migration in the population. The concomitant acceptance of this technology is shown by the fact that advantages, disadvantages, and the quality of the outcome no longer have to be justified. In this context, dental technology plays an important role in planning, designing, and milling or printing mock-ups and surgical guides, provisionals, and fixed and removable final restorations using a great variety of materials (eg, metals, composites, ceramics, zirconia). The important try-in stage of wax-ups and prosthetic teeth set-ups will soon be replaced by virtual try-ins based on scanned articulated models and photographs/videos of the patient. Not only the dentist but the patient as well will view the proposed new esthetic and functional look on the screen; both will be able to change some of the proposed aspects, and finally a milling machine or a printer will produce the final restoration in the right color and design with only minimal intervention by the technician and dentist.

We will have to adapt to a major change in our profession. Theoretically, we are already there, although new technologies can be frustrating given that high investment costs, the necessary extensive education of all the people involved, and the long learning curve tend to slow down the foreseen changes. For the same reasons, most teaching institutions show only slow adaptation to these changes.

It is estimated that by 2050, there will be 2 billion people aged older than 60 years. This segment of the population will have a higher susceptibility to chronic and life-threatening diseases and tooth loss.[4] Worldwide, oral disease is the fourth most expensive disease to treat,[5] and elderly people will need payable dental treatment methods and materials. They will look for less invasive clinical steps, greater simplicity, high product quality, predictability, less patient involvement, and enriched quality of life as a whole. The shift from analog to digitally generated production processes should change (and ideally simplify) clinical and technologic procedures and adapt the communication of students with patients to the new premise.

We are not far from the reality of fusing and analyzing our patients' genomes so that oral and systemic risks, including behaviors and attitudes toward care, can be identified accurately.[6] As a consequence, we will be able to simulate and assess outcomes of different treatments in advance. This is technically very promising, as especially in the treatment of our elderly patients new procedures should be more beneficial (simpler, more affordable, and predictable) than current treatment methods.

At the same time, the most important personal interaction between the dentist/prosthodontist and the patient has to survive this technical revolution. The time gained by more efficient clinical and technical

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procedures must be invested, especially with our frail aging patients, in more time for diagnosis, dialog, and maintenance care.

Kassebaum and Bernabé's systematic review showed that while the global age-standardized prevalence and incidence rate of edentulous people (those with severe tooth loss) decreased between 1990 and 2010, the prevalence increased gradually with age.[7] It is generally accepted that there still is an elevated need for complete denture therapy. However, not every patient can afford the costs of fabricating a complete denture. These people remain untreated. Furthermore, the academic community's overt emphasis on dentist-mediated clinical and technologic protocols has largely ignored patient-mediated expectations and concerns. In fact, provocative short-term reports[8] on simpler yet equally successful methods for complete denture fabrication for prosthetically adaptive patients underscore the merits of saving clinical time and cost reduction.

Companies in the digital field claim a workflow for fabricating complete dentures in only two clinical sessions.[9] The outcome is a milled denture that is more accurate than a conventional denture since no deformation by polymerization occurs. Furthermore, it can be duplicated when lost or when rebasing is necessary. New fabrication techniques will invite development of improved biomaterials that are stronger, less porous, and more resistant to adherence of a pathologic biofilm; they also can be easily laser-marked with a patient's unique identification. All these benefits are especially suitable for patients in long-term nursing homes, particularly when so many factors must be respected in treatment planning, such as multimorbidity; polypharmacy, including side effects such as dry mouth; fragility; cognitive impairment; patient compliance and physical resistance to treatment; functional limitations; the cost-benefit ratio; and in certain cases, patient life expectancy.

Digitization will also provoke changes in the educational field. Millennial students are different from earlier generations. While teaching, they expect immediate, customized information and 24/7 access; they read less and prefer visual presentation of decision tree learning strategies. As experienced video gamers, they are familiar with virtual reality simulation. The traditional mentoring relationship wherein the older advisor guides a young student will be supplemented by reverse mentoring, in which knowledge will percolate up from the bottom.[10] Reverse mentoring is a learning relationship between a mentor who is young and exceptionally literate in a new aspect of technology or social behavior and a protégé who has more life experience but is not familiar with the technology or behavior. In other words, teachers bring the clinical experience and students add the value of new technology, especially by producing teaching material using new means (videos, apps, etc). This process will be challenging, as teachers from the older generation feeling safe as mentors are confronted with the fact that students from younger generations can easily trump their position in the hierarchy. The only chance for the traditional mentor is to endure the level of discomfort required to gain a new (digital) perspective.[10]

Of course, this drastic hierarchical change will not only affect the workforce, leading to several very different generations working simultaneously, it will also lead to a very different dentist-patient relationship. Patients are becoming increasingly literate in the area

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of dentistry; they will ask more frequently for second opinions. Dentists will have to integrate—besides the technical advancements—a great deal of biopsychosocial and ethical information.[11] Based on the generational differences between dentist and patient on the one side and their abilities to communicate on the other side, many challenges remain to be solved.

In summary, we will be faced with the creation and fusion of digital data from different sources—data-analyzing systems, simulation software of treatment plans and outcome, milling and printing solutions in parallel with material science advancements, and robotic systems replacing a large part of manual labor. At the same time, the digital revolution should produce biologic and economic advantages for patients and reduce the time and energy needed from clinicians and technicians and, overall, allow more people to benefit indefinitely from the sophistication of digital prostheses. It is hoped that the time gained by reducing the clinical and technologic steps can be invested in better examination, diagnosis, and treatment planning for each patient, leading to more personalized dental medicine. In addition, the fusion of medical and dental data into digital medical records will nurture interdisciplinary patient management based on best-practice standards, guidelines, and workflows that will strongly attract the next generation of dentists to the profession.

This progress should please us, since it will ideally make dental treatment more affordable, acceptable, and attractive to even more patients. As prosthodontists, we are the natural leaders of a disruptive dental technology. Let's resolve to demonstrate our leadership!

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