Expanding the Application of Digital Dentistry with 3D Patient Monitoring

Nelson R. F. A. Silva, DDS, MS, PhD
Department of Restorative Dentistry, Universidade Federal de Minas Gerais, Belo Horizonte, Brazil

Jonathan L. Ferencz, DDS
Department of Prosthodontics, New York University, New York, New York, USA

Guilherme C. Silva, DDS, MS, PhD
Department of Restorative Dentistry, Universidade Federal de Minas Gerais, Belo Horizonte, Brazil

Digital dentistry is an integral part of modern clinical practice, given its numerous perceived advantages and improvements in efficiency, technical precision, and routine predictability. Patients have also benefitted from preferred time considerations, engagement, and comfort. Moreover, novel and diverse dental technologies continue to improve aspects of diagnosis and communication. The first thing that probably comes to mind when digital dentistry is discussed is computer-aided design/computer-assisted manufacturing (CAD/CAM)–produced restorations, given the technology's impact via intraoral scanners, CAD software, and milling/printing units, which are already an important part of routine clinical workflow in a global context. However, contemporary digital dentistry now surpasses this initial concept, since developments in equipment and software capabilities permit planning and simulation of functional occlusal movements as well as esthetic outcomes. Additional applications already include design and manufacture of removable prostheses, surgical guides, and orthodontic aligners. Current practices for monitoring patients employ analog processes that are subject to enormous variations and vulnerability to misleading data. However, a novel software tool now allows dentists to monitor patients through three-dimensional (3D) intraoral images combined with powerful software for data analysis (Trios Monitoring, 3Shape). Special algorithms enable the software to superimpose 3D scans recorded at different times and then calculate time-dependent dimensional changes or structural displacements. These changes/displacements are then represented graphically and numerically, permitting easy interpretation and comparison among the different scan times. *Int J Prosthodont 2019;32:XXX–XXX. doi: 10.11607/ijp.6052*

Minimally invasive procedures and conservative approaches are mandatory—indeed, essential—in today's practice. The use of tracking procedures via constant monitoring might present a significantly useful clinical tool: With precise data of different clinical scenarios recorded over time, dentists can provide proper care and better decide why, when, and how to proceed when making clinical decisions. Examples of clinical applications of this novel three-dimensional (3D) digital monitoring tool involve analysis of tooth and restorative material wear, occlusion, gingival recession or growth, and orthodontic tracking.

The prevalence of tooth wear is a clinical challenge given the inherent difficulty of obtaining precise micrometric in situ measurements. Conventional methods are limited to comparing stone casts obtained at different times, while current technology (3D scans of the patient's dental arch with an intraoral scanner at baseline and at any subsequent appointments) permits software superimposition of the scans, resulting in precise measurement of any wear in teeth or restorations.

Correspondence to:
Prof Nelson R. F. A. Silva
Universidade Federal de Minas Gerais
School of Dentistry
Department of Restorative Dentistry
Room 3301
Belo Horizonte, MG, Brazil 31270-901
Fax: +55 3198949-2405
Email: nrfa.silva@gmail.com

Submitted July 30, 2018;
accepted September 6, 2018.

Orthodontic treatment progress is commonly assessed using photographs, radiographs, or measurements on stone casts. Color 3D visualization and calculation of teeth displacement with the monitoring tool would assist not only orthodontists but also general dentists in checking treatment progress, which also improves patient education and motivation. Along with the treatment timeline created, another positive aspect is greater practice efficiencies, since the digital recording of 3D scans/images eliminates the need to archive multiple stone casts.

Gingival recession is often a prevalent esthetic and functional concern for several patients. With its risk of progression, an appropriate treatment must be considered. **[AU: Changes OK?]** Micrometric measures of the exposed cervical area of tooth structure obtained at different periods would definitely help dentists make appropriate clinical decisions. Furthermore, gingival volumetric changes assessed by the monitoring tool software can help in the assessment of outcomes of treatments such as gingival grafts, bone augmentation, or bone substitute grafts.

In addition to the obvious clinical potential, this tool also offers clinical research potential. Prospective studies could benefit from the simplicity and reproducibility of this digital application, and numeric data assessed by measurements at different times can be used for quantitative analysis of various clinical conditions.

In summary, intraoral scanning can capture and register color clinical images in an easy and noninvasive approach at countless time intervals. Novel software algorithms are able to superimpose 3D images, calculating dimensional changes at the click of a button. The potential of 3D monitoring is immense, and with the advance of artificial intelligence and its built-in capacity for data analyses, this monitoring tool will allow dentists and researchers to precisely calculate volumetric reading and anticipate potentially adverse clinical outcomes.

RECOMMENDED READING

Ahmed KE, Whitters J, Ju X, Pierce SG, MacLeod CN, Murray CA. Clinical monitoring of tooth wear progression in patients over a period of one year using CAD/CAM. Int J Prosthodont 2017;30:153–155.

Ferencz JL, Navarro JM, Silva NRFA. High-Strength Ceramics: Interdisciplinary Perspectives. Chicago: Quintessence, 2014.

Hinze M,Janousch R,Goldhahn S,Schlee M. Volumetric alterations around single-tooth implants using the socket-shield technique: Preliminary results of a prospective case series. Int J Esthet Dent 2018;13:146–170.

Martins AV, Albuquerque RC, Santos TR, et al. Esthetic planning with a digital tool: A clinical report. J Prosthet Dent 2017;118:698–702.