Introduction

Records are an essential and integral component of diagnosis and treatment planning. Moreover, the acquisition of records allows the required communication between the clinician, laboratory, patient, and other third party stakeholders. This is critical in all aspects of dentistry, but holds immense value in implant dentistry. Unfortunately, there is a growing epidemic in which clinicians are utilising the minimal amount of records. This becomes a paramount issue in the delivery of predictable and successful dental prosthetics.

Records may take many forms, but they tend to originate from two different groups: concrete and virtual. Concrete records include impressions and models, while virtual records encompass modalities such as cone bone computed tomography (CBCT) and intraoral scans. Each group has their own strengths and weaknesses, yet the literature seems to suggest that CBCT provides an abundance of information, especially for implant dentistry.

Computed tomography

Computed tomography (CT) has revolutionised diagnostic radiology. Since its inception in the 1970s, its use has increased rapidly, with the annual number of CT scans, in the United States alone, now being over 70 million. By its nature, a CT unit involves larger radiation doses than the conventional X-ray imaging procedures. Consequently, a typical CT series results in radiation doses that are associated with a small, yet statistically significant increase in lifetime cancer risks. The quantity most relevant for assessing the risk of developing cancer from a CT procedure is the ‘effective dose’. A diagnostic CT procedure produces an effective dose in the range of 1 to 10 mSv, with a dose of 10 mSv possibly being associated with an increase in the likelihood of cancer of approximately 1 in 2000. The risk of radiation-induced cancer is much smaller than the natural risk of cancer; however, this small increase in risk for an individual becomes a public health concern if large numbers of people undergo increased numbers of CT screening procedures unnecessarily. There is strong evidence suggesting too many CT studies are being performed in the United States and it has been speculated that one third could be replaced by alternative approaches, or not performed at all.

Furthermore, in the dental office setting, the large size, high cost of the equipment and logistics makes it improbable for the clinician. Likewise, with a cost per scan ranging in the hundreds to thousands, the procedure can be challenging for patients. Thus, although CT has numerous beneficial aspects, there are barriers to the technology from both the clinician’s and patient’s perspective. Subsequently,
other records acquisition techniques have gained increasing popularity.

**Cone beam computed tomography**

Cone beam computed tomography (CBCT) is a variation of the traditional computed tomography (CT) system. With CBCT, an X-ray beam, in the shape of a cone, rotates around the patient to produce a 3-D reconstruction of the craniofacial area. Dental CBCT was developed so that dentists could have a small, less expensive machine still capable of producing 3-D images. The equipment is used for various clinical applications, including dental implant planning, visualization of abnormal teeth, evaluation of the jaws and face, cleft palate assessment, diagnosis of dental caries, endodontic assessment and diagnosis of dental trauma. Thus, CBCT provides a fast, non-invasive method of addressing a number of clinical questions. Moreover, compared to the conventional CT, it has a limited X-ray beam, offers a shorter scan time, uses a lower radiation dose, and contains fewer imaging artifacts. Nevertheless, to accurately read a soft tissue phenomenon, a 24-bit contrast resolution is needed. The dynamic range of CBCT for contrast resolution can only reach 14-bit maximally and consequently CBCT is not the best imaging modality to evaluate soft tissues. Additionally, it does not provide the full diagnostic information available with conventional CT. The aspect of cost, technology implementation, skills acquisition and radiation exposure also hinder the utilizing and implementation of CBCT in the dental office.

**3M True Definition Scanner**

Launched in the USA in October 2012, the 3M True Definition Scanner (Fig. 1) is a relatively new digital intraoral scanner. Its 3-D video capture technology allows the dentist to digitally capture images of the patient’s dentition (Fig. 2). The scanner’s technology instantaneously stitches the images together to generate an accurate replica of the patient’s oral anatomy. Patients can therefore have a better understanding of their oral situation and the treatment procedures. Furthermore, the preciseness of the data provides the clinician the required records to design and fabricate prostheses, such as orthodontic appliances, crowns and bridges, all without the need for impressions or models. This eliminates the time and cost associated with impressions, model fabrication, potential for material distortion and the issue of patient discomfort. In addition, the 3M True Definition Scanner digital files can be used with any system that accepts STL files, a common file format used for saving three-dimensional objects. Dentists can easily share files and work with laboratories and other open source technologies to design and fabricate prostheses and delivery quality treatment to the patient. However, there are limitations to the technology. Like any new technology, there is the period of skill acquisition for the clinician and, although the unit is mobile, it does require space (note: a compact, tablet-based unit has been recently released). Additionally, while the True Definition Scanner captures the dentition, there is a lack of reference to the patient. Once the scans have been complied into an image, the image has the ability for rotation in three dimensions (Fig. 2). Figure 3 depicts the same clinical image but oriented in different positions. The incisal edges of the laterals have been demarcated. Determining which orientation is the ideal one becomes difficult without reference points. Figure 4 illustrates required references planes of interest for the rehabilitation of complex cases that require facial form as a reference for the predictable and successful fabrication of aesthetic prostheses.

**MaxAlign**

Given that it accurately and efficiently captures and documents important patient information for the laboratory, third party insurance, and patients,
MaxAlign (Fig. 5) is a tablet-based technology that serves as a communication tool for clinicians.\(^{18, 19}\) The program is a modified virtual facebow application that, unlike conventional facebows, enables the accurate mounting of casts alongside a patient’s image.\(^{18}\) Thus, MaxAlign presents a novel approach to the virtual acquisition of records and communication. In three steps, the dentist can capture a photograph of the patient’s teeth, document the width of the centrals (Fig. 6), and record the occlusion.\(^{20}\) The accurately mounted casts provide information that can be used for diagnoses and treatment planning and offers an easy reference for the mounting of models.\(^{18, 19}\) Using MaxAlign with a LabStand, the lab can easily use photographic overlays to mount the models, anatomically referenced on the patient.\(^{20}\)

Ultimately, the increased accuracy and accessibility in patient data reduces lab guesswork on cases and delivers predictable results efficiently.\(^{20}\) As MaxAlign is a mobile, tablet-based technology, many barriers to utilisation are eliminated. For instance, as the technology is mobile, it does not require any office space consideration. It is also cost-effective, possesses negligible radiation concerns for the patient and has a gentle learning curve for the clinician and staff.

**Merging virtual technologies**

Recent research has investigated a new application utilising MaxAlign with the True Definition Scanner...
by merging and correlating the intraoral images (Fig. 7). MaxAlign provides the reference and frames the 3-D intraoral digital impression with the landmarks of the patient’s face, providing crucial information to the lab in anterior aesthetic and complex prosthodontic cases. Additionally, early investigation has also merged images from digitised wax-up scans with the referenced patient image from MaxAlign (Fig. 7). By applying the transparency control on MaxAlign, the patient and other third parties, can now have the ability to immediately ‘try-in’ the proposed restorations and view a before and after effect within the context of the patient’s face. This can aid in patient communication and understanding of planned treatment.

**Conclusion**

Records will continue to have a significant requirement in the diagnoses, treatment planning and delivery of predictable and successful prostheses. With the growing pressures on the dental profession, including economics, office space limitations, patient concerns and skill acquisition, it is crucial to develop accurate and informative technologies to maximise patient information acquisition and communication. Although CBCT and virtual planning remain the ‘gold standard’, there are real patient and clinician limitations to the technologies. The utilisation of low-radiation, mobile, tablet-based technologies to merge patient information, has become an exciting avenue that will continue to have an increasingly important role in implantology and dentistry.

**References**


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