A simple chairside digital workflow

Linda Greenwall[1] and Benedict Harrison[2]

Intraoral scanning equipment has been rapidly introduced in dental practices as there are improvements to the technology in the last decade.

Computer-aided design (CAD) and computer-aided manufacture (CAM) is available to dental practitioners for the production of in-surgery restorations and devices using milling and printing technology.

This article will outline an overview of 3D scanning, its uses in general practice and discuss a simple chairside digital workflow of an indirect restoration.

A brief historical background

Dental biomaterials have been used in general dentistry for many years. Fillings inserted into crowns have been reported as early as the Neolithic period 6,500 years ago, with beeswax being the material of choice.

Historically a dental impression was needed for a technician to cast and construct a prosthesis.

Recent innovations in intraoral scanning have drastically improved their ability to acquire precise and accurate information with speed and ease. This enables dentists and technicians alike to view and design in an accurate virtual environment (Bernardini et al, 2012).

In recent years, computer technology and the development of CAD/CAM has allowed dentists and technicians to manufacture prosthesis using a digital workflow, and enabled them to make restorations out of millable materials such as composite, ceramic and zirconia and polymethyl methacrylate (PMMA) (Russo et al, 2019; Kilhara et al, 2019).

[1] Dr Linda Greenwall BDS MGDS MRS RCS MSc FFGDP FICD BEM, Specialist Prosthodontist, London, UK

[2] Dr Benedict Harrison BDS, Private Practitioner, London, UK

Figure 1: Preoperative photo of the clinical situation showing the distal fracture that had developed.

Figure 2: Preoperative radiograph showing significant crack in the distal marginal ridge of LL7.

Figure 3: After removal of composite and reduction in cusp height to remove fractured cusps. Once the caries is removed and fracture chased out we can decide on the most appropriate material for the restoration.

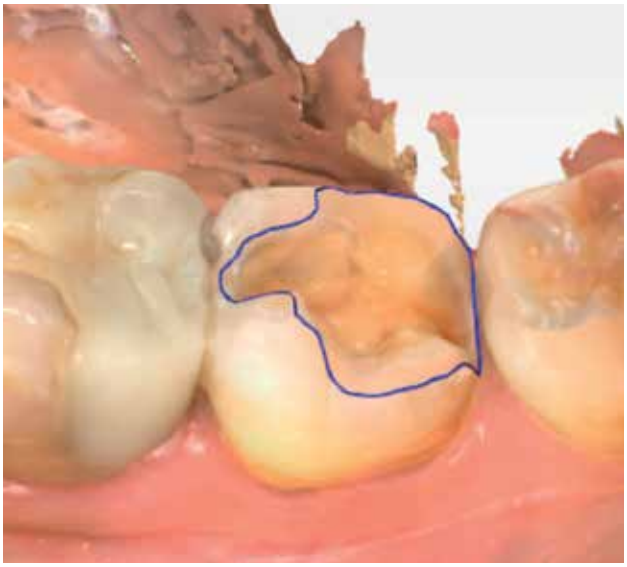

Figure 4: Scan of preparation and automatic margin detector. This margin is adjusted to the clinician's specification.

Types of CAD/CAM systems

There are three different CAD/CAM production concepts in dentistry described in the literature:

1. Chairside production – all components in the CAD/CAM system are located in the dental surgery
2. Laboratory production – a traditional working sequence

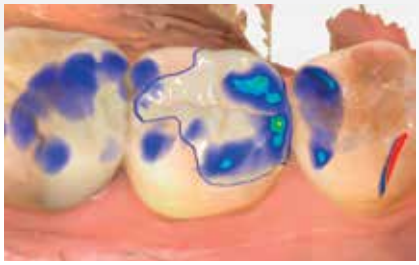

Figure 5: Restoration is designed using Cerec. Patients occlusion can be visualised with colour pressure areas. Restoration contacts can be turned on and off.

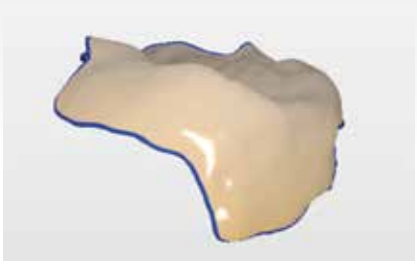

Figure 6: Lower model can be removed from the design to help add and remove from the virtual wax up. This is particularly useful when designing the restoration contact point.

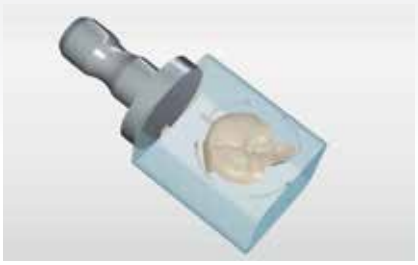

Figure 7: Once happy with your design, position the sprue on your restoration to a favourable position.

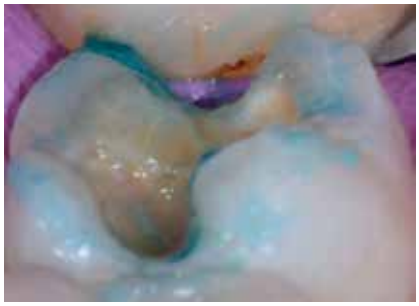

Figure 8: Cementation process – etch 20 seconds (Super Etch 37% phosphoric acid).

Figure 9: Washed and dried.

Figure 10: Application of Stae bond after Hurriseal application.

between a dentist and a laboratory. Once a laboratory receives impressions, these are cast then the CAD/CAM production starts by scanning the models. This enables the laboratory to digitally design and manufacture the prosthesis

3. Centralised production – laboratories send a design to a centralised production centre for milling, printing or pressing, this avoids the need for laboratories to purchase expensive production equipment (Baroudi and Ibraheem, 2015; Beuer et al, 2008).

The CAD/CAM in surgery system in dentistry comprises of four major components (Baroudi and Ibraheem, 2015; Beuer et al, 2008):

1. Digital scanner – a tool to convert physical geometry to digital information (such as Primescan, Trios 4, Emerald S, Itero Element 5D)
2. Software component – computer aided design software (Cerec, Trios, Planmeca)
3. Milling machine (Cerec MC-XL, Roland DWX-4W, Planmill 40/E4D Mill)
4. Millable block – ceramic, composite, PMMA and zirconia.

Scanning

Intraoral scanning devices have been around for many years, but have recently taken huge steps to make them a viable and effective tool for the general practitioner.

Historically, powder had to be used in conjunction with the scanner to provide an optical efficient environment to collect data. Scanners available on the market today are powderless and colour accurate. Many have adjunctive tools, such as shade analysing and caries detection.

Accuracy of scanning

There is not an exhaustive amount of research on the accuracy of digital scanning when compared to conventional analogue impression techniques.

The pace at which technology is improving makes it hard for research to stay up to date and relevant as digital scanning is constantly changing.

Some studies have reported better accuracy of scanned preparations using optical scanning (Abduo and Elseyoufi, 2018). However, a review by Abduo et al (2018) showed that intraoral scanning was just as accurate as conventional impressions in short spans, but during full arch scanning

Figure 11: Application of D/E resin.

Figure 12: Application of Relyx Unicem.

Figure 13: Seating and curing of the restoration.

there was more perceptibility to inaccuracies.

Ultimately, for diagnostic and short span scanning, digital impressions are comparable to conventional impressions (Abduo and Elseyoufi, 2018).

Acquisition of a good quality virtual model

1. Dry field – the use of a three in one and a vigilant nurse with a saliva ejector can make obtaining the scan much easier. A device such as an Optragate (Ivoclar Vivadent) that deflects the lips is also beneficial to clear the scanning field
2. Dark environment – the dental light, as well as surgery lights, should be switched off to enable the scanner to work more effectively
3. Good preparation design – clear, smooth margins, ideally supragingival. Use of retraction cord essential for margins sub or juxtagingival
4. Half arch impression – this reduces inaccuracies in the impression and also makes designing the restoration easier when moving the virtual model on the software program
5. Obtain the bite registration and opposing arch before preparation – this reduces the scanning time after preparation. Ideally, the bite registration should be taken in an upright position with the patient biting together, but not clenching.

A simple case is highlighted step by step to show the digital work flow.

Case: Preparation of a ceramic combination inlay/onlay

This patient, due to a clenching habit, developed a deep distal crack on the lower left second molar. The crack was situated on the distal marginal ridge of the tooth and had developed a fracture on the occlusal surface where decay had penetrated into the crack.

Table 1: (Mangano et al, 2017)

Advantages and disadvantages of chairside scanning	
Advantages	**Disadvantages**
More time efficient	Deeper margins more difficult to scan
Less patient discomfort	Learning curve
Better communication between dentist and technician	Cost of purchasing equipment
Better communication between dentist and patient	Ensuring good isolation to record accurate details
Less waste	Dry field is essential to pick up accurate details of the prep
Accurate fit of restorations due to better identification of margins	Initial learning curve can take more time to do
	More time needed to learn the software and design software

Figure 14: Final restoration LL7.

To preserve and protect the tooth from further fracture, it was decided the best and most conservative options would be to design an inlay/onlay combination, overlaying the distobuccal and distolingual cusps and keeping the inlay design/occlusal design (Figures 1 to 14).

Treatment time was 90 minutes from start to finish. This helped to save the patient a second appointment and patient did not have to have a temporary restoration.

The overall outcome was a conservative onlay made to protect the tooth from further breakdown and preserve the remaining tooth structure.

Conclusions

Using the digital scanner and Cerec digital design software, an onlay was created chairside using a milling machine and ceramic block.

It was an effective way to undertake restorative and aesthetic dentistry. More research is needed and more training is needed, as further materials and software are introduced onto the dental market.

References

Abduo, J, Elseyoufi M (2018) Accuracy of Intraoral Scanners: A Systematic Review of Influencing Factors. The European Journal of Prosthodontics and Restorative Dentistry 26(3): 101-121

Baroudi K, Ibraheem SN (2015) Assessment of Chair-side Computer- Aided Design and Computer-Aided Manufacturing Restorations: A Review of the Literature. Journal of International Oral Health *7*(4): 96-104

Bernardini F, Tuniz C, Coppa A, Mancini L, Dreossi D, Eichert D, Turco G, Biasotto M, Terrasi F, De Cesare N, Hua Q, Levchenko V (2012) Beeswax as dental filling on a neolithic human tooth. PloS one *7*(9): e44904

Beuer F, Schweiger J, Edelhoff D (2008) Digital dentistry: an overview of recent developments for CAD/CAM generated restorations. British Dental Journal 204(9): 505-511

Goracci C, Franchi L, Vichi A, Ferrari M (2015) Accuracy, reliability, and efficiency of intraoral scanners for full-arch impressions: a systematic review of the clinical evidence. The European Journal of Orthodontics 38(4): 422-428

Kihara H, Hatakeyama W, Komine F, Takafuji K, Takahashi T, Yokota J, Oriso K, Kondo H (2019) Accuracy and practicality of intraoral scanner in dentistry: A literature review. Journal of Prosthodontic Research

Lo Russo L, Caradonna G, Biancardino M, De Lillo A, Troiano G, Guida L (2019). Digital versus conventional workflow for the fabrication of multiunit fixed prostheses: A systematic review and meta-analysis of vertical marginal fit in controlled in vitro studies. The Journal of Prosthetic Dentistry 122(5): 435-440

Reprinted with permission from Aesthetic Advances December 2019.