Full digital integration in restorative dentistry

Bruce Lee
BDS, Clinical Director, T32 Dental Center, Singapore

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3M Lava Ultimate, 3 Shape Trios, Digital Impression, Digital wax-up, Hybrid Ceramics, Ivoclar Emax, Pre-Preparation Scan Lithium Disilicate, Zirconia, ZirkonZahn.

ABSTRACT
Aim The aim of this case report was to plan, manage and restore patients using a fully digital workflow. This involves the use of various digital platforms, from digital diagnostic wax-ups to the fabrication of provisionals, digital impression taking, and the final CAD-CAM prostheses. These were done via different hardware and software platforms between different manufacturers. To illustrate the workflow, a case is described of a patient who had significant wear on her lower anterior teeth caused by her lower anterior teeth opposing fixed porcelain restorations on her maxillary anterior teeth as well as a deep incisal relationship.

Material and Methods Following initial photographic, diagnostic impressions and face-bow records, a diagnostic digital wax-up was done at an increased Occlusal Vertical Dimension (OVD). Assessment was made as to whether the diagnostic wax-up was adequate to raise the bite and reduce the overbite of the patient. Provisional restorations milled from a Poly-(Methyl Methacrylate) (PMMA) block (ZirkonZahn) (based on the digital wax-up) were then cemented as trial therapy for the patient to 'road-test' the new OVD. Upon confirmation of the new OVD by the patient, these bonded provisionals were scanned as ‘pre-preparation guide’ for later reference during design phase. The provisionals were also used as reduction guides during preparation. Digital impressions (3 Shape Trios) and inter-arch relationship (Bite) were taken after preparation of each segment. Final prostheses (Lithium Disilicate, Ivoclar Emax; Zirconia, ZirkonZahn; Hybrid Ceramic, 3M Lava Ultimate) were then planned, designed and milled from these digital impressions. Working models and dies were ‘3-D’ printed models. The various milled prostheses were then cemented segmentally according to the manufacturers’ recommendations.

Results The fit of the prostheses was assessed and found to be clinically acceptable both clinically and on the ‘3-D’ printed models. They also were able to satisfy the aesthetic requirements of the patient.

Conclusion Through the digital workflow, though performed with hardware and software from different manufacturers, it was possible to successfully achieve the entire treatment planning, design and treatment process, delivering high quality, well-fitting and aesthetically pleasing results to the patient.

Introduction
The use of digital smile analysis and design has seen increased interest among dentists. However, the complete integration of the digital workflow in restorative dentistry from examination and discussion of patient’s needs and desires, to diagnostic wax-up to fabrication of provisionals (prototypes), digital impression taking to the fabrication of final restorations via CAD-CAM may not be so easily and fully established. This is due to multiple cross-platform (both soft and hard-ware) connections in the integration process.

The following case report attempts to ‘join-the-dots’ and achieve predictable as well as excellent aesthetic and functional outcome for the patient.

Case report
A 63-year-old female patient presented at our center requesting for a solution to her aesthetic and jaw pain concerns. She had extensive restorative work done on her upper jaw more than 8 years earlier, but has been unhappy with the results. Amongst the reasons for her unhappiness was that she did not like the color of her upper crowns, saying that they were too ‘yellow’ and ‘patchy’, with too much characterizations. She also claimed that she used to have a diastema between her central incisors, which she liked and wanted to maintain, but her dentist then insisted that she looked better with the space closed. In recent years, she has also developed acute sensitivity in her lower front teeth as well
as ‘fatigueness’ and ‘ache’ in her jaws which was why she was wearing a nightguard (Figures 1A, 1B, 1C, 1D).

Examination and data collection
Clinical examination revealed excessive wear on the labial and incisal edges of the lower anterior teeth and a deep anterior bite. Grinding against the upper full porcelain restorations caused the wear and the deep-bite may have resulted in the jaw ‘aches’/‘fatigue’ she described.

As the fixed restorations on her upper jaw were still in very good condition, we advised her to not proceed with any major treatment for the moment. Instead, we advised to treat her lower jaw in order to manage the excessive wear and aesthetic issues.

Finally, the patient also requested that she needed to get all her treatment completed in 2 months, in time for her son’s wedding day: a real challenge indeed.

Diagnostics and treatment plan
With the study models mounted, it was transferred to the dental laboratory for scanning and mounting on a virtual articulator. In order to relieve the deep incisal relationship, we decided to raise her bite by 3 mm anteriorly and a diagnostic wax-up was completed digitally at that increased occlusal vertical dimension (Figure 2).

The prototype provisionals
The digital diagnostic wax-up was assessed and approved. A set of prototype provisionals based on the digital wax-ups was fabricated.

These were milled from a single PMMA ((Poly) methyl methacrylate) (ZirkonZahn PMMA Block) (1, 2, 3). For aesthetic and functional try-in, these were bonded directly on the patient’s dentition without preparing the teeth. The patient was allowed to ‘road-test’ these provisionals for 2 weeks (Figure 2, 3).

After 2 weeks, the patient reported that she was happy with the increased height of her lower teeth, and also reported much relieve to her jaw discomfort. The plan then was to convert her to the final restorations.
in segments. This was to allow her more time on this new bite position with minimal changes and to shorten treatment times during each session.

Final treatment plan
To achieve the plan from the diagnostics, we can be minimally invasive in our tooth preparations and economically prudent as well.

We decided to bond onlays over the existing implant crowns instead of redoing the entire implant abutments and crowns.

The following is the material chosen for the final restorations (4) and treatment is carried out in the sequence below.

1. Lower right side (Stage 1)
   - Tooth #47 and implant #46. Onlay preparations only.
   - Tooth #45 and 44. Onlay preparations with labial veneer reduction.
   - All restorations are milled from Resin Nano Ceramic (3M Lava Ultimate Blocks) (Hybrid Resin/Ceramic) Blocks.

2. Lower left side (Stage 2)
   - Implants #37 and 36. Splinted onlay preparations only.
   - Tooth #35 and 34. Onlay preparations with labial veneer reduction.
   - For splinted onlay restoring splinted implant crowns #37 and 36, zirconia (ZirkonZahn Prettau® Zirconia) onlay is the restorative

Figure 2 Mounted models were sent to the laboratory for scanning. A virtual wax-up was done using the ZirkonZahn Modellier Lab Software at the raised occlusal level. Milled PMMA provisionals on mounted models.
material of choice, whereas for #35 and #34 Resin Nano Ceramic (Hybrid Resin/Ceramic) Blocks were chosen.

3. Lower anterior (Final Stage)
- Lower anteriors #33 to 43 will be prepared minimally to receive porcelain laminate veneers milled from lithium disilicate (IPS E.max® Lithium Disilicate) blocks.

Pre-preparation scanning and tooth preparation
Prior to preparation, a pre-preparation scan was made with the 3Shape TRIOS® intra-oral scanner (Figure 4).

The aim was to capture the provisionals that have been in function. This will greatly facilitate the design of the individual final restorations in terms of occlusal morphology and pattern.

Tooth preparations were done using the bonded provisionals as reduction guides. Double cord technique was used to prepare for impression taking (Figure 5). Once each segment was prepared, a digital impression (3Shape TRIOS® intra-oral scanner) was taken of the preparations complete with the digital bite registration (5). The case was then ‘sent’ digitally to the laboratory for design and fabrication.

Laboratory design and fabrication
Upon receipt of the case, the technician worked using the 3Shape Dental Systems™ to design the individual prostheses by marking out the margins,
Figure 6a Digital impression of the lower right side. Impressions are taken in full color but may be viewed in ‘stone’ color, as an alternative way to view and identify the margins (6).

Figure 6b Digital impression of the lower left side. Note the splinted implant crowns on tooth #36 and 37.

Figure 6c Digital impression of lower anterior. Note the minimal and conservative preparations.

Figure 6d Digital bite registration.

virtually ‘wax-up’ the morphology of the individual teeth with reference to the pre-preparation scans and the teeth library in the software. 3D Models are also printed to finalize the occlusion and fit (Figure 7A).

Fit and bond
The prosthesis were bonded adhesively segmentally. Even the Zirconia splinted onlays were primed with Zirconia Primers before bonding to the implant crowns.

After completion of each segment, the patient was allowed to function on them for a week before returning to continue with the next segment (Figure 7C).

Conclusion
With the treatment carried out in stages, the entire procedure (including the prototype provisionals) was completed in 7 weeks. The patient was happy with the results aesthetically and has also settled comfortably into her new increased vertical dimension with relief from her jaw pains (Figure 8).
We have successfully applied a completely digital workflow to restore this complex case in a short period of time. From digital wax-up to provisionals to the final prostheses. With digital intra-oral scanning proving to be the vital link between the clinician and the laboratory. All these achieved across different platforms (in terms of hard and software systems). Reducing downtime, increasing efficiency and at the same time maintaining and even improving precision in the prostheses we deliver to our patients.

References

Figure 8a Completed treatment after 7 weeks, after final bonding of anterior veneers

Figure 8b Completed treatment


