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CAD/CAM

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CE article
The Virtual Facebow

special
Aesthetic Digital Smile Design – Part II

case report
Implant-supported prosthetic concept

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One step further with CAD/CAM

Dr Steven Soo

_My presentation at the Dental Tribune Study Club Symposium at IDEM Singapore 2014 highlighted some of the advantages and disadvantages of the use of CAD/CAM in dentistry. My goal was to enable clinicians to see how it might become more widely accepted in their daily practice and remove some of their reservations. The next generation of dentists will hopefully come to view traditional methods of manufacturing dental prostheses in the same way as we now view fixed partial dentures as a way to replace missing teeth before implants.

CAD/CAM methods for conventional dental and implant-borne prostheses have gained popularity for a variety of reasons. Despite many advantages in terms of cost and convenience, the uptake of this relatively new technology is slow, hinting at a reluctance to try something new.

Many, if not most, clinicians still choose to have fixed implant-borne multi-unit prostheses fabricated by traditional methods of casting and veneering precious metal alloys. However, the associated high technical and material costs may be prohibitive to the group of patients who need this treatment modality the most. To this end, more cost-effective alloys, including base metal alloys, have been cast and veneered with a variety of tooth-coloured materials with good success. CAD/CAM takes this one step further. In fact, materials such as zirconia, which has revolutionised dental prostheses, would not be in use were it not for CAD/CAM.

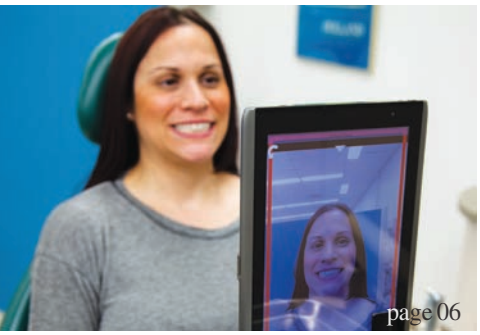
There has been much discussion around the problem of achieving passivity of fit, the lack of which, it has been postulated, can contribute to mechanical and biological complications. The multiple steps and materials used in impression taking, casting a working model, producing a wax pattern, casting in metal alloy then veneering in tooth coloured material all lead to a certain degree of misfit.

CAD/CAM can help to address this common problem. The use of digital dentistry is more common than clinicians might think, as the laboratory processes involved have already been widely implemented and dental technicians can take the credit for driving the use of the technology forwards. The next step is to adopt digital technology to replace some of the clinical steps in fabricating a prosthesis, namely the impression stage, which leads to production of a working cast.

These steps can introduce cumulative inaccuracies, as well as consume a variety of materials that are then discarded. In addition, there are time-savings to be made, perhaps not in the initial stages of learning and integrating new technology, but, once familiar with the systems involved, all will benefit from the improved and efficient workflow.

I wish you a pleasant read of this CAD/CAM issue, and I hope you will find various interesting articles in it.

Dr Steven Soo
Dental specialist in prosthodontics at Specialist Dental Group® in Singapore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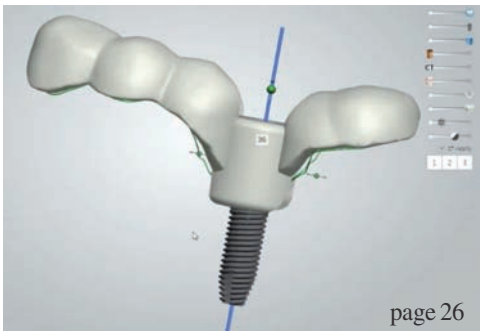
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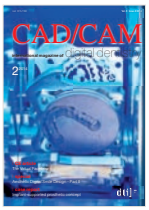

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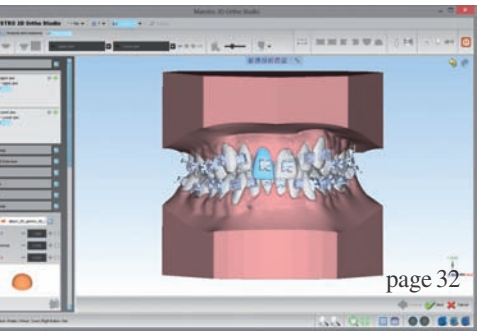
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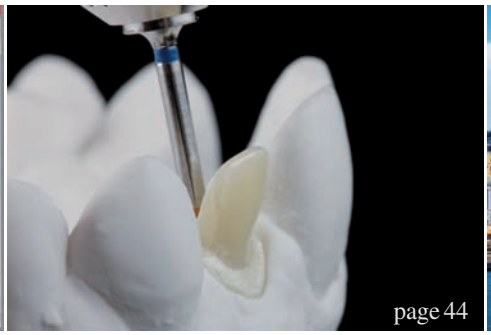
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The Virtual Facebow
A digital companion to implantology

Author_Dr Les Kalman, USA

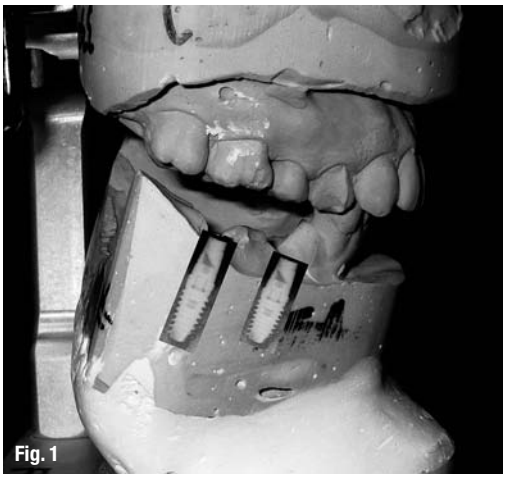
Fig. 1


Fig. 2

Fig. 1_Implant treatment planning.
Fig. 2_Analog facebow.

_Abstract

The Virtual Facebow has been developed as an open-source tablet app that provides an alternative to the conventional facebow for the mounting of casts to an articulator.

The Virtual Facebow implements several design features to prevent and minimize errors, provide accurate mounting and reinforce the anatomical considerations associated with articulators. The Virtual Facebow is an effective, efficient and accessible digital companion to dental implant diagnoses and treatment planning.

_Introduction

Prior to the delivery of dental treatment, carefully established diagnosis and treatment planning is required. This is particularly important with dental implant therapy.[1]

To assist the process, the mounting of a patient's diagnostic casts remains an important step, as it allows the assessment of critical factors such as occlusion, implant position and forces direction.[2] It also allows exploration into prosthetic options,[2] such as angled abutments (Fig. 1).

To support proper mounting of patient casts, a facebow, which aligns the maxilla to relative facial planes, can be utilized. Errors in the utilization of the facebow, or complete lack thereof, create critical errors in diagnoses and treatment planning that become magnified in the design and delivery of implant prosthetics.

The Virtual Facebow has been developed as a digital substitute to the analogue facebow to address the shortcomings.

_Background

Analog facebow

The facebow (Fig. 2) facilitates the mounting of the maxillary cast to the articulator. The Whip Mix Quick Mount facebow (Whip Mix, Louisville, KY) is composed of a caliper-type instrument that anchors into the ear canals and is balanced by the bridge of the nose.

A bite fork is utilized, embedded with polyvinylsolixane, to register the position of the maxillary teeth. The bite fork is then transferred to an articulator, through the use of a transfer jig. The maxillary cast is positioned and mounted to the upper portion of the articulator.

_ce credit CAD/CAM

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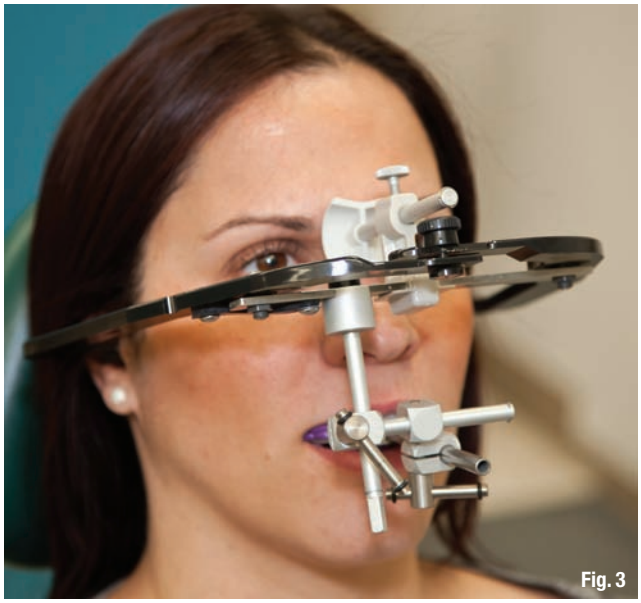
Fig. 3


Fig. 4

Fig. 3_Facebow application.
Fig. 4_Incorrect mounting.

The facebow is a largely omitted during the diagnosis and treatment-planning phase due to its shortcomings. It can prove tedious and uncomfortable for the patient, as the ear canal projections, bite fork and nose bridge can apply pressure and pain. The facebow can prove tedious and frustrating to the clinician, due to the subjective positioning and multiple adjustments[3, 4, 5] (Fig. 3).

If utilized incorrectly, the facebow can result in errors, which include:

_facebow application;
_assembly;
_patient position;
_verification;
_in maxillary cast orientation;
_in mandibular cast orientation;
_occlusal relationship.

Errors have direct impact on the assessment of inter-arch space, occlusal contacts and force direction (Figs. 1-4). Errors will then affect the diagnosis, treatment plan, implant type, abutment angle and prosthesis. If inaccurate mounting errors are not recognized early, the outcome may yield a compromised result, poor prosthesis (form and function), timely adjustments and a remake.

As with any compromised result, the ultimate consequence would include inefficient use of time, unnecessary costs, patient unhappiness, stress on the clinician and an unnecessary environmental impact.

Virtual Facebow

To rectify these compounded issues, the Virtual Facebow app (VF) (Research Driven, Komoka, Ontario) was developed as a digital substitute for the analog facebow.

Several safeguards were incorporated to minimize errors in positioning and orientation. The VF has been developed as an app that incorporates patient photos, alignment verification, anatomical relevance and confirmation of occlusion. The open source tablet app has been developed to be accessible through affordable tablet cost, affordable app cost and unlimited use.

Data can be readily shared, used on various devices, requires no specialized software, is simple to open and read and provides an easy-to-email option. The VF was designed to be efficient, effective, economical and educational. The VF's current requirements include: any supported tablet device with an Android operating system, a back-facing camera and a minimum system update of 4.0.3. The VF is currently available on the Google Play market.

Although the VF app has been designed to be used as a standalone substitute for the analogue facebow, several peripherals have been developed to offer even more simplicity to the process. A patient positioner verifies patient orientation, a vertical tablet stand simplifies operation and an articulator mount positions the maxillary cast.

_Methodology: Case study

Clinical

The following is a step-by-step instruction on the VF utilization. Properly position the patient and confirm orientation. Place the tablet in the stand within 6 to 12 inches of the patient. Launch the VF app (Fig. 5).

Fig. 5_Tablet-patient position.
Fig. 6_Screenshot face-skull.
Fig. 7_Occlusal contacts.
Fig. 8_Screenshot tooth map.

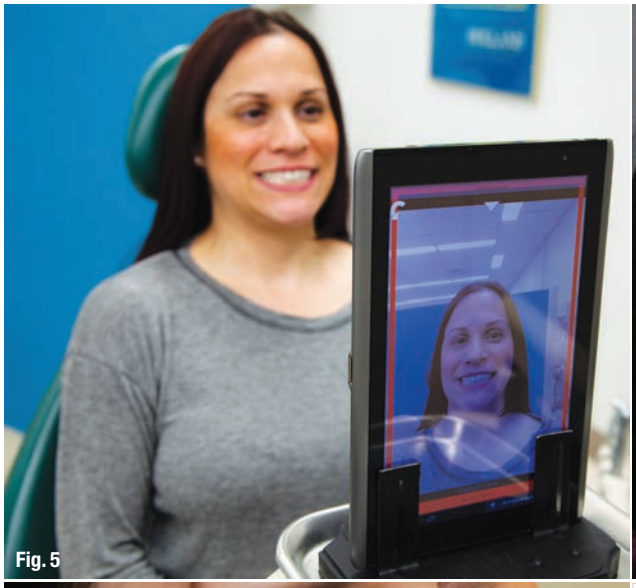
Fig. 5


Fig. 6

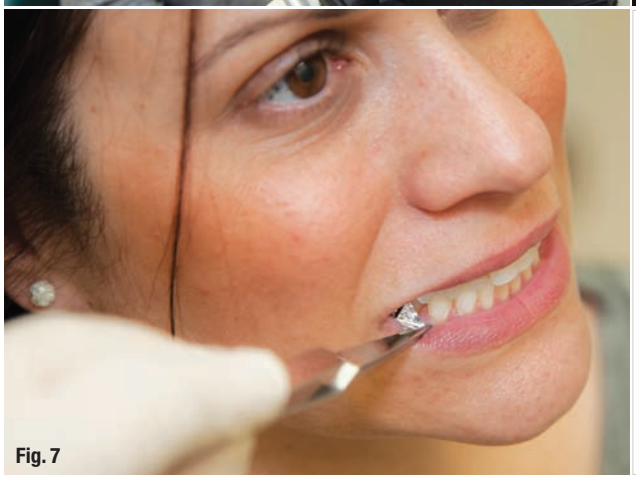
Fig. 7

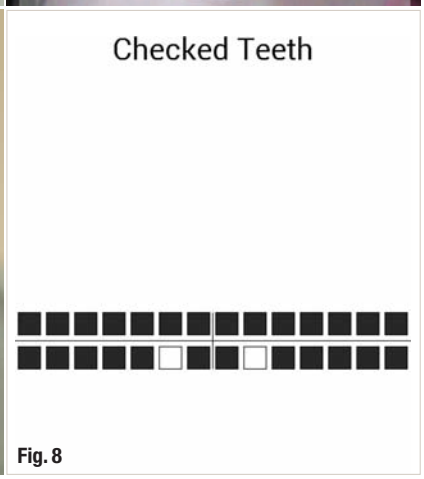

Fig. 8

Position the skull and reference markers over the patient's image. Confirm alignment of tablet and markers and simply take a photo. Resize and reposition the patient photo if required and save the image. Verify orientation of midlines, incisal edges, occlusal planes and anatomical references by altering the transparency of either the skull or face image (Fig. 6). Clinically assess occlusal contacts (Fig. 7) and input via the touch screen (Fig. 8). Clinical component has been completed.

Laboratory

If the clinician has delegated mounting to the lab - oratory, then the records phase has been completed. The following applies to those who mount their own casts. Position the tablet in the stand 6 to 12 inches from the cast and launch the VF app. Place the maxillary cast on the articulator mount (Fig. 9). The patient image will appear.

Adjust orientation of cast (tilt) to confirm alignment with the patient markers. Verify orientation of midline, incisal edges, occlusal plane and facial references (Fig. 10).

When the cast is correctly positioned, simply take a photo. Resize and reposition the image if required and save the image. Orientation can be confirmed by altering the transparency of either the face or cast image. Mount the maxillary cast to the upper articulator. The record of occlusal contacts (Fig. 8) will then be displayed. Position the mandibular cast to the maxillary cast, confirming contacts,and mount the mandibular cast.

The VF will then generate a composite of the skull, face and cast. The operator has the ability to alter the transparency of any image to reconfirm the position of the skull to the patient's face and, ultimately, to the cast (Fig. 11). The laboratory component has been completed (Fig. 12).

The files are then saved on the hard drive as a series of PDFs and JPGs, both of manageable size. The user has the option of emailing either the complete series or individual images, in PDF or JPG, to any third party. The user has the ability to refer back to any image but cannot modify any of the images. A series of six screenshots document the VF process.


Fig. 9

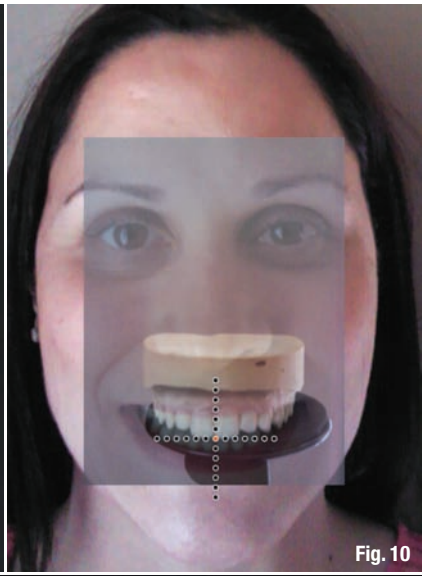
Fig. 10


Fig. 11

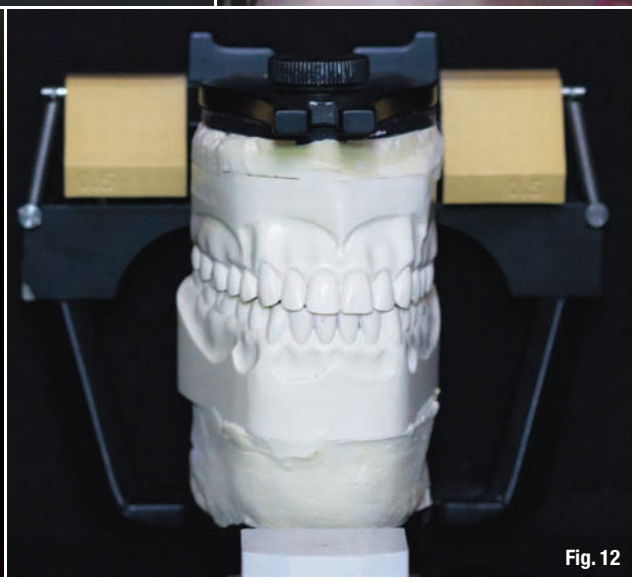
Fig. 12

Fig. 9_Cast photo.
Fig. 10_Screenshot face-cast.
Fig. 11_Screenshot skull-face-cast.
Fig. 12_VF mounted casts.

_Discussion

The VF utilizes several proprietary design features that enable a tablet device to have the ability to record, confirm and reproduce the orientation of the maxilla to relative facial landmarks. This enables a simple, efficient and effective technique in the mounting of the maxillary cast to the articulator.

The VF also records the maxillo-mandibular relationship vital to correct mounting, enabling the accurate mounting of complex implant cases (Fig. 13). With exact mounting, the proper position and angulation of dental implants can be achieved (Fig. 14).

A pilot study was recently performed at the Schulich School of Medicine & Dentistry at Western University. Patients with restored dental implants were selected. A practitioner assessed the occlusion. Impressions and required records were taken, and casts were mounted.

One dental student utilized the analogue facebow, the other the virtual facebow. Mounting was assessed in terms of: cast position (anteriorposterior and lateral), quantity of occlusal contacts, required clinical, laboratory and total time and cost. Preliminary analysis suggests that the VF is more accurate, efficient and cost-effective. Data will presented in the near future.

The use of cone-beam computer tomography remains the gold standard of dental implant treatment planning.[6] However, many clinicians have barriers to the technology either from limited finances, physical access or intimidation. Many implant cases are planned and delivered with little to no clinical records, other than final impressions. The Virtual Facebow provides a digital companion that is accessible, affordable and understandable.

_Conclusion

The Virtual Facebow is an open-source tablet app that not only facilitates the mounting of the maxillary