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FEATURES SECTION

Current Products and Practices

OrthoCAD™: digital models for a digital era

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This article describes the use of OrthoCAD™—a digital study model capture, assessment and storage system. It is estimated that approximately 10% of orthodontists in USA and Canada now utilize digital study models, and improving technology is making it increasingly popular worldwide. The technology behind digital study models is briefly reviewed. The OrthoCAD™ system is described, and the advantages and disadvantages of using digital study models are highlighted.

Key words: OrthoCADTM, digital study models

Introduction

Study models have long been an essential part of the orthodontic process.

They have traditionally been cast out of either plaster or stone and have performed 2 main functions:

- to provide information for diagnosis and treatment planning;
- to provide a 3D record of the original malocclusion, any stages during correction and the outcome of treatment.

Although study models are almost indispensable to the orthodontist, because they are cast in plaster or stone they do have a number of drawbacks in terms of:

- storage and retrieval;
- diagnostic versatility;
- transferability;
- durability.

Following recent articles on 3D imaging[1,2] this article focuses on OrthoCAD™ technology, a system to produce 3D digital study models. This system is designed to overcome the problems highlighted above with traditional study models. Digital photographs and digital radiographs are already in regular use. The introduction of 'virtual study models' may allow the use of a fully electronic patient record for the orthodontic patient.

OrthoCAD™ software has been developed by CADENT, Ind (Computer-aided Dentistry, Fairview, NJ, USA). This author had previously used a study model diagnostic/storage software program by QuickCeph (QuickCeph Systems, San Diego, California, USA), which is based on digitally photographing the models in the 5 usual views (front, right and left lateral, and upper and lower occlusal). These digitally photographed 'models' could then be stored, viewed (in the 5 views taken), and tooth widths digitized from the occlusal views for space assessment. This relatively basic system, took second place to QuickCeph's excellent cephalometric software and, although it solved storage problems, it did not allow any manipulation of the models and assessment was limited. In addition, the models had first to be cast and set up for the photographic input.

OrthoCAD™, by comparison, gives the orthodontist a virtual 3D set of models, which can be manipulated in all planes of space; sectioned in any plane and measured along any plane with considerable accuracy.

OrthoCAD™ uses state-of-the-art computer-aided design (CAD) to optically scan in the 'model' image from a 'plaster equivalent'. These are then presented to the orthodontist through the patented OrthoCAD™ software user interface that allows both structured and free manipulation of the 'models' in virtual space, and data collection through a range of diagnostic tools.

Review of development

The concept of 'digital' study models in not new. Apart from 2D digital photographic representations (as

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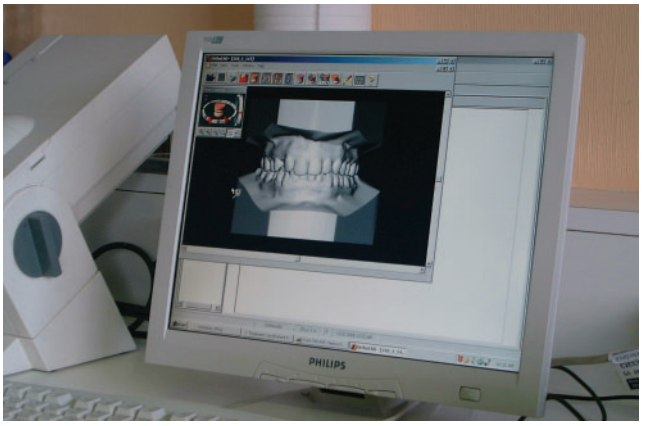

Figure 1 Computer screen visualization of 'virtual' study models by OrthoCAD™

described in the QuickCeph system above), researchers have attempted to develop '3D models' through laser technology. Holographic images have also been investigated;[3,4] however, most early technologies required complex capture equipment and proved costly. Laser technology is also limited in capturing areas between adjacent teeth, which are overlapping.

Scanning technology has been available since the mid-1990s, but software development over the past 5–6 years has refined this approach dramatically. These advances have made the capture of scanned-in images commercially viable and it is this computer-aided design (CAD) technology that OrthoCAD™ uses to produce digital study casts.

Figures from OrthoCAD™ show that some 10% of orthodontists in the USA and Canada utilize digital models. Expansion into the world-wide arena has just started.

So far, there has been limited research into the accuracy of scanned-in models but the few papers published on the subject show that measurements taken from digital models are within an acceptable range when compared to measurements taken from traditional cast models.[5,6]

Producing and using digital models

High quality impressions. It is essential to take high quality impressions and a bite registration.

The impressions can be taken in a high quality alginate, polyvinyl silicone or polyether material. The aim is to produce a set of impressions that will be as accurate as possible and as dimensionally stable as possible, considering that they have to be shipped to the USA. This author's preference is a high quality alginate, such as Orthoprint (Zhermack, Rovigo, Italy) taken in rigid plastic impression trays.

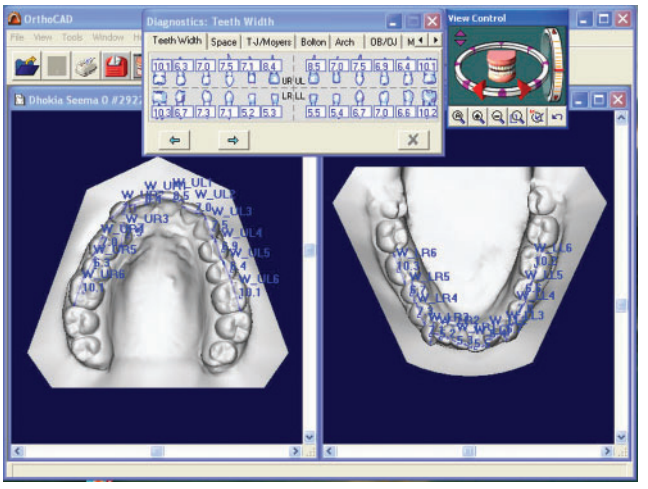

Figure 2 Computer screen visualization of a measurement function on OrthoCAD™

The alginate impressions are sanitized, wrapped in damp paper towel and are packaged in sealable plastic bags to ensure moisture retention. This ensures that the impressions will remain pliable (and stable) for up to 5 days. If the impressions will not be delivered by the 5th day (collecting a number of patients' impressions over a few days for posting), then we consider using a polyether such as Impregum (ESPE Dental AG, Seefeld, Germany).

Scanning of the impressions by Cadent. When the impressions are received, they are made up into 'plaster equivalents' and optically scanned, without destruction of the 'plaster equivalent', into the OrthoCAD™ computer system.

About 10 days after dispatch to the USA, the patient's 3D 'virtual models' are downloaded on to your computer (Figure 1).

Manipulation of the virtual models. Manipulation is made possible by OrthoCAD™'s propriety software, which allows:

- 'grab and drag' manipulation in all planes of space;
- static views from any perspectives;
- transverse and vertical sectioning in any desired plane;
- occlusogram views, highlighting occlusal contacts;
- diagnostics—tooth widths measurements, space assessment, Moyers and Tanaka-Johnston predictions, Bolton analyses, arch width measurements, and overbite and overjet measurements (Figure 2). Measurements are made with a 'virtual' caliper and automatically stored. These are then calculated against arch form and arch size to give space discrepancy, etc. as noted above;

- post-treatment American Board of Orthodontists' assessment;
- jaw alignment assessment.

Along with this, notes can be made, views and measurements printed off or e-mailed to the patient or another orthodontist/health care professional.

All of these tasks are fully explained in the Help section of the software.

Advantages and disavantages

OrthoCAD™ models have all the advantages of plaster models, apart from being able to hold the casts 'in your hand' and provides the clinician with a bit more:

- a simpler and more effective method of measuring and storing data taken from the 'virtual' model;
- simpler storage and integration into the patients 'digital' file, along with the digital photographs, x-rays and clinical notes;
- simpler retrieval and viewing along with the patients other clinical data—especially at the chairside;
- easy transferral to others in the patient's healthcare circle via prints or email attachment.

The only other apparent disadvantage with 'virtual models' is that they cannot be mounted and articulated in reference to the patient's tempero-mandibular joint function, although the jaw alignment assessment software does approach this partially. The costs will be discussed later in the article.

This, and not being able to 'handle' the virtual models, are minor drawbacks when compared with what digital models can provide and should you want a 'hard copy' of your virtual models, these can be made up by a process called rapid prototyping. This is not done by OrthoCAD™, but is outsourced to a '3D printing bureau'.[7]

Other services offered by OrthoCAD™

OrthoCAD™ have expanded the technology that produces digital models to offer additional services:

Virtual set-up

This is a prediction system based on the straight–wire philosophy. It assumes wires are attached to the teeth and virtual tooth movements can then be undertaken. It allows the clinician to simulate the effect of extractions, different archwires and different bracket prescriptions and positions. The accuracy of this system is yet to be fully tested.

Indirect bonding

The clinician sends the impressions and bite registration as usual, along with prescriptions and appliances. Once a treatment plan and bracket positions are approved on screen, OrthoCAD™ can fabricate indirect bonding trays.

Bracket placement

The principle behind this technique is that the clinician plans the position of each bracket on each tooth on the digital model. Additional hardware is then needed at the chairside to ensure the person placing the bracket has positioned it exactly in the prescribed position. This involves using a bracket placement device that is connected to the computer. This device includes a miniature video camera that transmits real time images from the patient's mouth to the screen. When OrthoCAD™ detects an exact match between the projected image from the patient's mouth and the clinician-prescribed position on screen, an audio-visual sign is provided to let the clinician know that the bracket is accurately positioned and can be bonded.

How to get involved with OrthoCAD™

Registering with OrthoCAD™ (www.OrthoCAD.com) initiates the delivering of the OrthoCAD™ software CD and instructions.

The software is simple to load, and providing one computer is designated for 'model' downloads, the storage and manipulation software can be used on as many workstations as one chooses. The hardware system requirements are fully explained on the website.

The download computer, normally your server, requires an Internet connection and can be 'on-line' to act as a gateway for the automatic download that is usually scheduled overnight. The time taken for transfer will depend on the Internet connection speed, but as this takes place overnight, it is not usually an issue.

A folder containing the downloaded 'virtual model' files is created on the designated workstation or server and these files normally take up about 500 Kb of space each. Storage space is not a problem, but a separate hard drive for all OrthoCAD™ model files that are not in active use could be used.

At the time of writing the cost of OrthoCAD™ digital models is $36.00 per set of models—about £20.00. Add shipping costs of around £30.00 (the author typically ships 3 or 4 sets of impressions per box) and this brings a total cost for a set of models to around £28.00–£30.00.

The software for the digital models is provided free of charge.

Conclusions

OrthoCAD™ could revolutionize the way in which study models are utilized, stored, viewed and managed. The ability to rotate, tilt and section models, and hold them in any position, potentially allows for far more detailed analysis, with the added advantage of bringing the models up instantly, along with the other clinical information, chairside. In the era of the 'electronic patient record', when all patients information will be stored digitally, commercially available digital model systems, such as OrthoCAD™, will become the norm.

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Les Joffe is a specialist orthodontist in Harley Street, London, and a director of OrthoWorld, an orthodontic corporate in the UK. Les Joffe has no financial interest in OrthoCAD™ or Cadent Inc.

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