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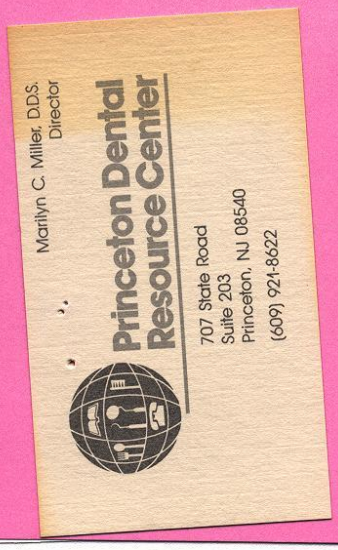
New
Technology
'N Trends

DENTAL INNOVATIONS FOR TODAY AND TOMORROW

Princeton Dental
Resource Center



COMPUTER-ASSISTED IMAGING TECHNIQUES

Twenty years ago, the notion of using computers in clinical practice would have been met with skepticism. Today, however, sophisticated technology is being combined with increased availability and lower costs of computers to produce exciting new developments in diagnostic imaging. Two computer technologies currently under development for dental practices are subtraction radiography and computer-aided design/computer-aided manufacturing (CAD/CAM).

SUBTRACTION RADIOGRAPHY

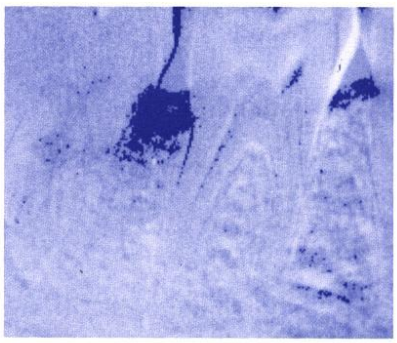
Subtraction radiography is a new radiographic tool which enhances clinicians' diagnostic abilities by enabling them to measure more precisely alveolar bone changes that occur over time. Subtraction radiography extends the capabilities of conventional radiography by:

- Standardizing images taken at different occasions, while adjusting for such variations as X-ray projection angle and film processing;
- Facilitating detection of early alveolar bone changes. Conventional techniques require a loss or gain of at least 30 percent of the bone mass at the alveolar crest before a change in the bone height is detectable. With this technique, a difference of just five percent is detectable; and
- Providing three-dimensional images that permit measurement of volumetric changes and better visualization of periodontal pockets.

HOW SUBTRACTION RADIOGRAPHY WORKS

Radiographs taken at different time periods are standardized. Although several techniques are utilized, one of the newest methods incorporates a device consisting of a cephalostat, which is inserted into the patient's ears to limit head motion, and a video-based visual feedback system. This video system records an image of the face at the moment the first radiograph or reference image is taken. To standardize subsequent radiographs, the cephalostat rods are again placed in the patient's ears, then the head is positioned so that it coincides with the alignment of the previously recorded image.

After a radiograph is taken, its image is digitized, that is, converted into "computer language." The computer stores the data from the first radiograph as a mathematical matrix consisting of tiny dots (pixels) that depict the grey level values of the film. The computer then changes the image from a negative to a positive image and retains it as a reference.



The dark interproximal areas in this subtraction radiograph represent bone loss.

Photo Courtesy of Marjorie Jeffcoat, D.M.D.

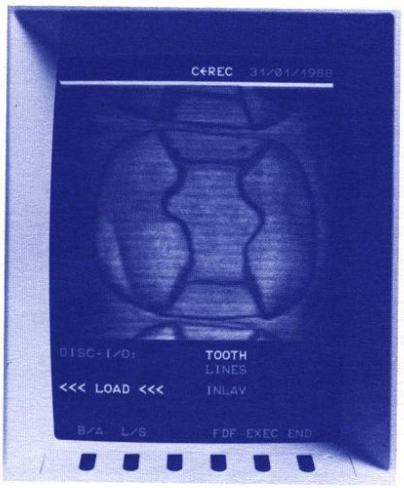
When subsequent radiographs are taken, the computer subtracts those images from a reference image to produce a "subtraction image." This subtraction image enables the clinician to visualize clearly the location and degree of hard tissue changes.

In the past, radiographic negatives were converted to positive prints and their differences then measured. The new computerized technique is faster and more precise. After additional refinements, developers of computer-assisted subtraction radiography expect that dentists will incorporate these systems into their practices in the future.

CAD/CAM

Computers are also being utilized to produce dental restorations. Computer-aided design, an imaging technique, and computer-aided manufacturing (CAD/CAM) systems, which are now widely used in engineering, are being combined and adapted to dentistry.

Obtaining data to create a dental prosthesis through impressions, casts, facebow transfer and jaw registrations is time consuming. CAD/CAM computer systems save chair time by acquiring that data optically. This optically-obtained information is digitized and stored by the computer. The two-dimensional image is then converted into a three-dimensional image that becomes the computer's equivalent to a dentist's stone or plaster cast.



A CAD/CAM system will use this optical impression to design an inlay restoration.

Photo Courtesy of Siemens Medical Systems

The computer stores information about ideal tooth anatomy, which can be used to help design a restoration. Once stored, interactive software programs enable practitioners to modify the ideal morphology to achieve a customized restoration. This process is similar to how laboratory technicians wax a restoration, adding wax to some areas and carving it away from others. When the computer-generated design is completed, tool paths for milling the restoration are developed and transferred to a milling machine for fabrication.

CAD/CAM systems offer numerous advantages over conventional restoration design and manufacturing techniques:

- Time is saved by eliminating many of the labor-intensive steps of the impression-die-lost wax casting technique;
- The CAD/CAM system offers the possibility of a one-appointment restoration, eliminating problems such as numerous temporary restorations, shifting of teeth between appointments and tissue irritation;
- Theoretically, CAD/CAM will be able to produce highly accurate restorations that will not require chairside adjustments;
- This technique will allow clinicians to employ materials never before used. Castability is not a requirement, and a milling machine will be able to create restorations from new types of porcelains, ceramics and composites, as well as from metals that are not suitable for casting; and
- Use of thin, strong materials will enable fabrication of restorations with reduced thickness, thus decreasing the amount of structure removed during tooth preparation.

Currently, there are three types of CAD/CAM systems under development. Despite individual differences, all three function according to similar underlying principles. The Swiss system is designed to fabricate restorations such as inlays, onlays and porcelain veneers. The French system produces crowns and is expected in the future to produce inlays, onlays, three-quarter crowns, three-unit fixed partial dentures and complete dentures. The Minnesota system, which is still under development, initially will fabricate crowns and eventually may be able to construct a wide variety of fixed restorations. Unlike the French and Swiss systems which use lasers to scan the tooth, the Minnesota system can use photographs or lasers to acquire the necessary data. Since the French and Minnesota systems have the capability to construct full coverage restorations, they are also programmed to integrate information on jaw movement and occlusal function.

An additional benefit of the French and Minnesota systems is that they can be set up for milling operations at a central laboratory. Under such a system, computers in dental offices will acquire the data and design the restoration. The information will then be transmitted to a central laboratory computer for milling. Eliminating the purchase of a milling machine will make the system more affordable for individual practitioners.

Milling operations for this CAD/CAM system, developed in France by Dr. Francois Duret, can occur at a central laboratory. The CAD/CAM's computers, which would be located in dental offices, acquire data and design the restoration. This information would then be transmitted to the milling machine for restoration fabrication.

Photo Courtesy of Dr. F. Duret
Hennson Technologies

Some European dentists now use a CAD/CAM system in their offices. If refinements in the CAD/CAM system are successful and computer costs continue to decrease, one may expect that this technique soon will be more widely incorporated in American dental offices.

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