DICOM WG 22
Dentistry

DICOM
Digital Imaging and Communications in Medicine

The Importance of Color in Dental Imaging

FDA ICC Summit on Color in Medical Imaging

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ADA

Hi, I'm Andrew Casertano and I am a consultant for the ADA. I am here today as a representative of DICOM WG-22, on Dental Imaging. I am here today to inform you on the importance of color imaging in dentistry and highlight our use cases. We have heard from our user community that they have several problems with the management and use of color imaging. We wish to collaborate our ongoing work effort with the international expert community assembled here.

The Potential of Misdiagnosis

- **The correct visual inspection is essential for better patient care**
- **Visible Light accuracy for identification**
- **Discrimination of shape**
- **Measurements**
- **Consistency in capture, exchange and display**

Our DICOM working group 22 consists of many diverse stakeholder of color imaging: dental providers & executives, technicians, researchers, dentists, specialists, including orthodontists, Prosthodontics, periodonists, oral and maxillofacial radiologists and surgeons, dental manufacturers laboratories and the vendors that build our cameras, modalities, information systems and software.

Performance Improvement

- **Accurate color reproduction will result in more efficient care**
- **Save resources**
- **Reduce rework**
- **Color improves provider fatigue**
- **Greater patient acceptance**
- **Faster treatment possible**

Single hand manipulation

Wide observation field (extreme focusing range)

High Resolution

Accurate color reproduction

Automated light regulation

Sterilization

Simple activation

Smaller the better unit

Image Stabilization to avoid retakes

New Areas of Treatment

- **Tele-dental Applications**
  - Reduces travel
  - Increases access to specialists
  - Web guidance and treatment
- **Multi-spectral analysis**
- **Narrow Band Imaging**
- **Education and training**

As dentisty becomes more mobile and accessible, it relies on the accurate reproduction of colors and textures in displays.

Education, Training, Communication and standardization is key to reduce variances.

Typical Use Cases

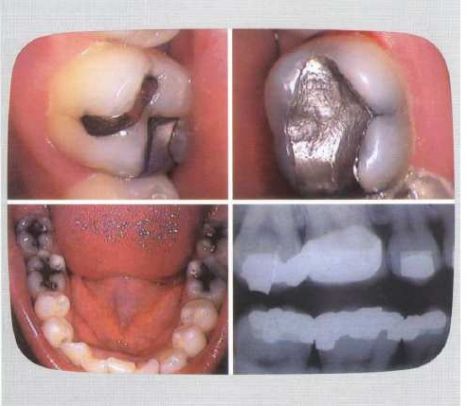
- **Treatment Planning**
- **Esthetic dentistry and implant treatment**
- **Insurance Attachments**
- **Root fracture**
- **Risk Assessments**
- **Materials and Prosthodontics**

For almost 20 years, we have promoted the standard exchange of color dental DICOM objects & services. The use of DICOM VL and XC objects in dental applications is rapidly growing. This is list of some of our typical use cases. Others uses include non and less invasive surgery, advanced diagnosis, surgery monitoring.

I'll now highlight these use cases in more detail.

Intraoral Camera

- **Diagnosis & Treatment Planning**
- **'pockets,' 'plaque deposits' and 'abscesses'.**
- **Diastema**
- **Gingival alteration**
- **Chin remold**
- **Malocclusions alteration**



WG-22 is currently working on DICOM CP375 that will improve the anatomic identification SNOMED codes of intraoral and extra-oral objects. An example for diagnosis and treatment planning, the dental provider wishes to identify the anatomic codes of the mandible, a particular tooth number, and the jaw region in the color and radiographic images that she acquired. In her information system, she identifies a planned alteration due to **malocclusions**. She may consult with an Orthodontist, who specializes in the straightening of teeth and modification of midface by exchanging dental information in a standardized format. Although the orthodontist is displaying the color object in a completely different system, the anatomic identifiers are consistent and correctly identified.

Materials and Prosthodontics

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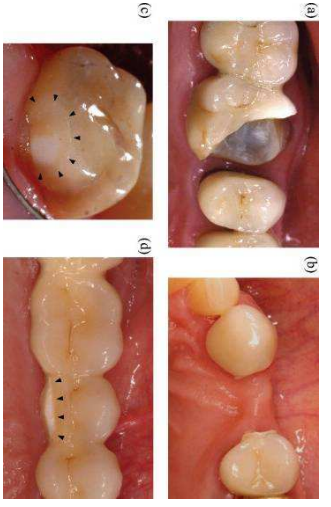
- **Shade selection procedure depends on various factors including translucency, contour and surface texture**
- **The impact of the color science can be seen on various restorative materials ranging from ceramics to maxillofacial prosthetic materials**



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Prosthodontics use VL photography for matching shade, fit and restoration of implants, crowns, bridges, veneers, inlays, and the complete and removable partial dentures.

One very complicated but necessary step is to include coding fields for all attributes necessary for ceramic replacement of teeth… not only color but also hue, shade, tranlucency, etc. A second step is to factor the lighting conditions including color temperature of the light source.

Next slide please

Oral Cancer Assessment

- **Oral Cancer is the 6th most common cancer in men (14th women) and the death rate is up 11 % over the last 5 years**

- **Changes in color or translucency of enamel**
- **White spot lesions**
- **Gray discolorations**
- **Black discoloration (arrested decay)**

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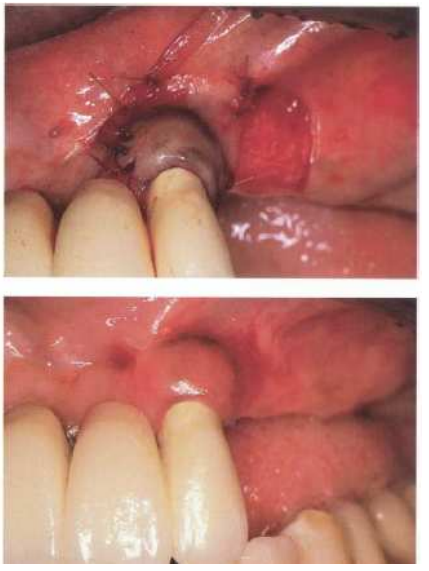
Oral and maxillofacial surgery includes Extractions, implants, and facial surgery. These surgeons diagnose and treat oral cancer and other diseases in the maxillofacial region. They use visible light photographs to monitor changes in color, detect white spot lesions, gray and black discolorations to help with oral cancer assessment.

Using an endoscope with improved brightness, light distribution, high-resolution images with better color reproduction capability, and larger display size, white plaque lesions can be examined at closer range, in greater detail than previously. There is recent research that shows that Narrow Band Imaging, or frequency range limiting analogous to the iris restriction, shows detection improvements over balanced White Light.

Periodontal Surgery

- **Direct, real-time visualization and magnification of the subgingival tooth root surface & recessions, aiding in the identification of deposits on the tooth surface**
- **Treatment using both Direct & Indirect Vision**



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In Periodontics, in order to study and treat diseases of the periodontium tissue as well as placement and maintenance of dental implants, requires Direct, real-time visualization and magnification of the sub-gingival tooth root surface & recessions, aiding in the identification of deposits on the tooth surface.

Anterior Restorations

- **Abfraction**
- **Abrasion**
- **Caries with loss of enamel**
- **Caries with Dentin Involvement**
- **Crown Repair**
- **Acid Erosions**

Closely matching natural teeth with an artificial restoration can be one of the most challenging procedures in restorative dentistry. Natural teeth vary greatly in color and shape. Dentistry provides the opportunity to restore or rebuild our patient's unique characteristics or to replace them with alternatives.

Whether restoring one tooth or many, the ability to assess and properly communicate information to manufacturing laboratory can be greatly improved by language of color and light characteristics.

It is only possible to duplicate in ceramic what has been distinguished, understood, and communicated in the shade matching process. This requires understanding what happens when incident light hits the surface of a tooth and some strategies for best assessing and communicating this to the dental laboratory.

Next Steps to Providers

- **Many of the issues and variability are due to human factors**
  - Education & Training required
  - Calibration between capture & display
  - ADA Technical Report 1050, Implementation Guidelines for DICOM in Dental Photography and Endoscopy

the ADA provides professional guidance to the international user community. About seven years ago, the ADA offered Technical Report 1029, the Practitioner Guide to Digital Dental Photography and Imaging. We have a current work item TR 1050, Guidelines for DICOM in Dental Photography to update and expand on this guidance to providers.

Next Steps

- **Determine where in the total imaging system we can make an improvement**
- **WG 22 has a DICOM work item regarding Visible Light**
  - Engage our PACS & modality vendors
  - Color Display Function
- **IHE Consistent Presentation of *Color* Imaging**

Since 1996, WG 22 set a goal any dental image, any where, at any time, using the DICOM Standard as the backbone of the interoperability effort. Our working group 22 has been very active in DICOM. In 1999, we participated in the development of Supplement 15, including the XC, ES and VL objects for photographs and endoscopes. WG22 has a current work item that may improve these objects and DICOM services to promote interoperability between dental systems. We wish to collaborate this ongoing work with additional DICOM groups such as WG13 VL.

The ADA also sponsors the Integrating the Healthcare Enterprise IHE Dental domain to communicate its commitment to interoperability. In IHE, we have developed our content profile, Secure Exchange of Dental Information (SEDI) that include the secure exchange of DICOM objects over either the web or email.

Affiliations and Disclosures

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Thank you for the opportunity to present the importance of color in dental applications here at the FDA today. We have heard from our user community regarding their problems with the management and use of color imaging. Together we can help to calibrate and standardize the total imaging process and help to remove variances that can cause misdiagnosis & waste resources.

We look forward in our future collaboration with the international color community assembled here.

Thanks to Dr. Allan Farman, Dr. Gregory Zeller, and the DICOM WG-22.