18th ICDMFR 2011 Hiroshima

Round Table Discussion

Digital Interoperability at the Dental Office and Hospital

Handout of Round Table Discussion

Session 28C3

Date: 13:00 – 16:00, May 28th

Room C

Chairs: Allan G Farman and Tomohiro Okano

Digital Radiography in Dentistry

Digital radiography is now the common modality in dental imaging. The percentage of radiographs which are taken in digital form, either both based on the storage phosphor plate technique of or on CCD or CMOS modalities, is in different countries well above 90% of all dental images. Other countries may have a somewhat lower percentage, but everywhere in the world the use of digital image acquisition is increasing rapidly.
The question is if digital imaging has really brought the improvements that we expected from this new technology. This gives cause for a few questions.

Does digital radiography result in a lower dose to the patient?

When digital radiology was introduced in dentistry, one of the advantages of this new technology that were strongly emphasized was the dose reduction compared to conventional film based images. Claims of a reduction of more than 90% were made. This is a percentage that could certainly not be achieved in clinical practice. If a reduction of 90% is not the reality, the question is obvious if is there is any dose reduction at all when changing from analog imaging to digital radiography?
The ICRP published a document in 2004, stating that digital imaging could provide a dose reduction, but certainly also has the potential to result in an increased dose without the radiologist or radiographer noticing the excess of radiation [1]. The inherent preprocessing of the raw digital image makes it possible to obtain a diagnostically perfect image, within a wide latitude of exposure conditions. It was shown that digital imaging in medical radiology does not lead to a dose reduction.
At the same time a study was performed focusing on the use of digital sensors in dental radiology [2]. The outcome of this study was those solid state sensors require less dose than analog x-ray films. The reduction, however, was considerably less than 90%. Phosphor plate systems could result in a lower dose, but it is certainly possible to create image that are diagnostically perfect using an exposure that is the equivalent of multiple film based exposures. The conclusions of this study were completely in line with the concerns expressed by the ICRP.
In another study by the same authors it was found that users of digital systems tend to increase the number of radiographs during their examinations [3]. The outcome of these studies was that, considering the limited dose reduction and the increase of number of radiographs, digital imaging in dental radiography will not result in dose reduction to the patient.
This leaves us with a few questions:

- Why is it that dose reduction was emphasized in the early years of digital radiography? Was it because of the importance that commonly is given to lowering the dose? It was certainly not evidence based.
- What can we do to weapon general practitioners to unsupported claims of sensor manufacturers.

Why is advanced image processing so seldom used?

A significant difference between conventional radiographic images and their digital counterparts is that digital images can be “manipulated” after they have been produced, while analog images have to be accepted as they are at the time of image acquisition and nothing can be changed afterwards. The image processing of digital images can be used for image optimization, image enhancement, feature extraction and other techniques intended to make the information contained in the image better accessible for diagnostic use. Image processing will never add new information, but it can be an effective method of making certain characteristics of the image better visible, and subsequently the information in the image that is based on these characteristics. Contrast can be increased to make initial caries lesions better perceivable. It can also be reduced to avoid the burn out of the bone contour of periodontal lesions. To some extent, under- of overexposed images can be corrected, thus avoiding the need for a retake [4, 5].

A more advanced application of image processing is digital subtraction radiography. Subtraction has been described in many scientific papers as a methods of reducing the anatomical noise and therefore improving the visibility of small changes of the lesions on radiographs taken at an interval of time. Subtraction radiography in principle assumes that the two images have the same projection geometry and gray scale distribution. Originally, this was achieved by connecting the patient rigidly to the film and x-ray machine. Today, the same result can be obtained by using software tools to register the two images and match density and contrast, thus enabling the general practitioner to apply this technique in daily practice [6, 7].

Although to the best of our knowledge there are no studies showing how frequently image processing tools are used in daily practice, it is obvious from simple observations that many users of digital systems do not apply image processing to the extend they could do, to enhance the diagnostic performance of digital imaging. One can ask the following questions:

- Is it true that image processing tools are used not very often?
- Is it true that users will not experience the benefit of image processing, depending on specific diagnostic tasks?
- If both questions are answered with a yes, how can we train clinicians in making a better use of the diagnostic advantages of digital image processing?

Do we really take advantage of the capabilities of digital imaging to its full extent?

Images are useful as a medium for communication. In particular digital images can be transferred easily over the internet or by other electronic transmission pathways. In order to communicate, it is essential that the sender and the receiver can understand each other. In other words, the image transmission has to be carried out following specific communication protocols. In another presentation during this round table discussion this issue will be discussed more in details, especially the more technical aspects. Within the context of the current presentation, it is of importance to know if digital imaging is used to its full capabilities in terms of sharing image information supporting the diagnostic process. Relevant questions are therefore:

- How common are protocols for image communication and are they widely applied?
- Do dentists use digital image information as an integral component of the electronic patient record?

Conclusion

Digital radiography was introduced in dentistry more than 25 years ago. It has not completely replaced analog radiography yet. When will this happen? And also, is digital radiography able to provide us with all the potential benefits of computer based image acquisition, storage, retrieval and processing?

References

[1] ICRP, Managing patient dose in digital radiology. ICRP Publication 93. Ann. ICRP 34 (1), 2004.
[2] Berkhout WE, Beuger DA, Sanderink GC, van der Stelt PF. The dynamic range of digital radiographic systems: dose reduction or risk of overexposure? Dentomaxillofac Radiol. 2004;33:1-5.
[3] Berkhout WE, Sanderink GC, Van der Stelt PF. Does digital radiography increase the number of intraoral radiographs? A questionnaire study of Dutch dental practices. Dentomaxillofac Radiol. 2003; 32:124-127.
[4] van der Stelt PF. Better imaging: the advantages of digital radiography. J Am Dent Assoc. 2008 ;139 Suppl:7S-13S.
[5] Brüllmann DD, Röhrig B, Sulayman SL, Schulze R. Length of endodontic files measured in digital radiographs with and without noise-suppression filters: an ex-vivo study. Dentomaxillofac Radiol. 2011; 40:170-176.
[6] Dunn SM, van der Stelt PF, Ponce A, Fenesy K, Shah S. A comparison of two registration techniques for digital subtraction radiography. Dentomaxillofac Radiol. 1993;22:77-80.
[7] See also www.emago.info, accessed April 2011.

Digital Radiography in Dentistry

Paul F. van der Stelt
Prof. Oral and Maxillofacial Radiology
ACTA
Amsterdam, the Netherlands

Round Table Discussion,
18th ICDMFR Hiroshima, june, 2011

Digital radiology

- The introduction of digital radiology in dentistry marked a new era of imaging with big potential.
- Promises:
  - Dose reduction
  - Image processing
  - Communication of information

Digital radiology

- What is the current situation?
- Dose reduction
- Image processing
- Image communication

Does digital radiography result in a lower dose to the patient?

Dose reduction

- Why is it that dose reduction was emphasized in the early years of digital radiography? Was it because of the importance that commonly is given to lowering the dose? It was certainly not evidence based.
- What can we do to weapon general practitioners to unsupported claims of sensor manufacturers.

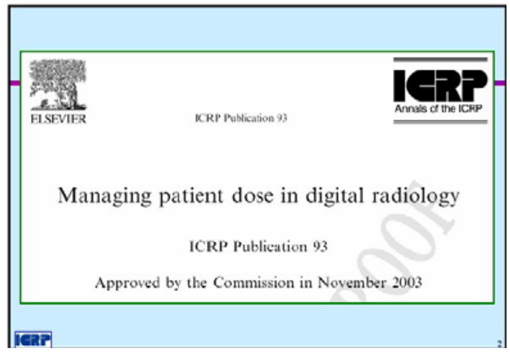
Dose reduction

- Today's dental practices expect the selected intraoral x-ray system to enhance image quality, to reduce patient dose and to increase rapidity. …..Three sensor sizes can be used for bite-wings, periapicals or paediatric patients resulting in up to 80-95% lower radiation dose compared to film.

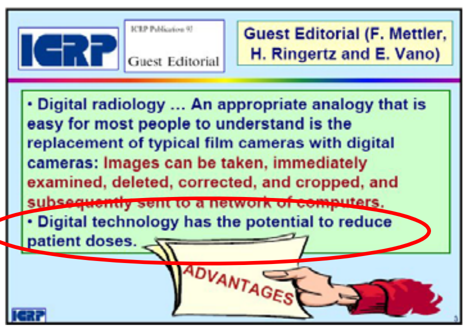
Dose reduction

- Your patients will appreciate that the DenOptix System can effectively reduce radiation levels as much as 90% compared to D-speed film.

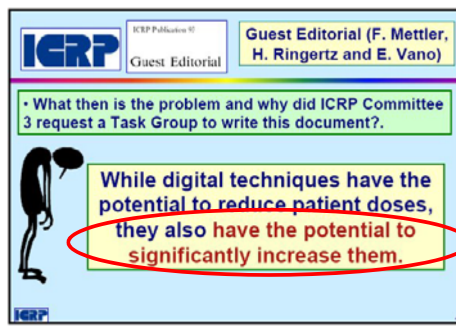
Dose reduction



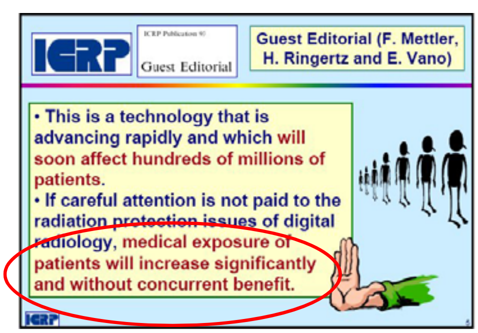
Dose reduction



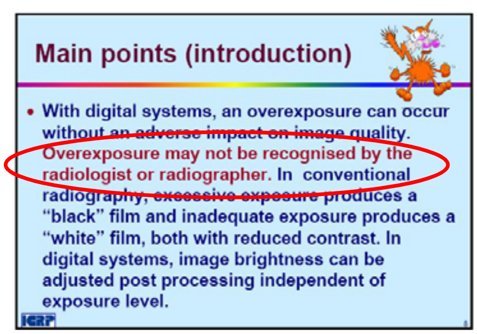
Dose reduction



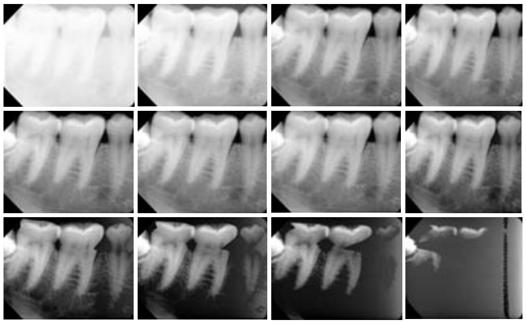
Dose reduction



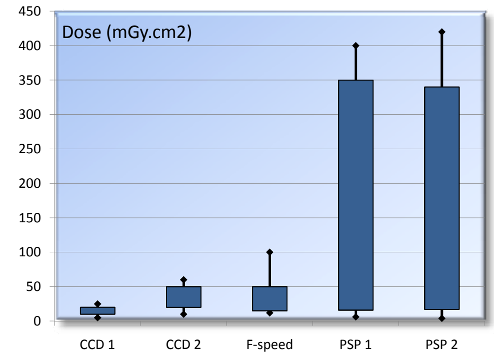
Dose reduction



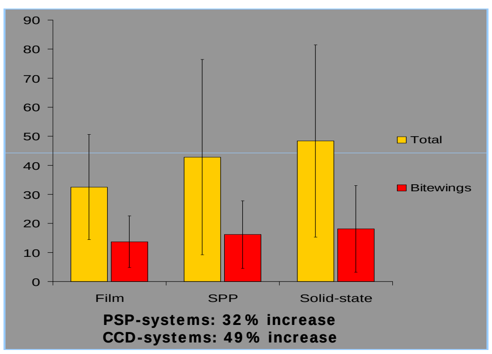
Dose reduction



Exposure latitude of digital systems



Number of x-rays per week



Conclusion

Dose reduction:

The effective dose reduction is, considering the larger number of exposures …

- For PSP systems about 0%.
- For CCD systems almost -30% (= **increase**).

Dose reduction is not a reason by itself to convert to digital imaging.

Why is advanced image processing so seldom used?

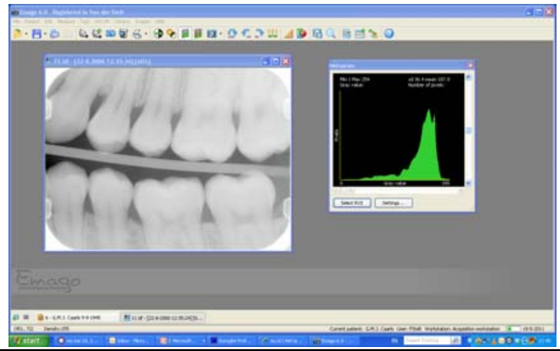
Image processing

- Computer guided optimization of gray value distribution
- Magnification and image callibration
- Image enhancement and filtering
- Digital subtraction radiography

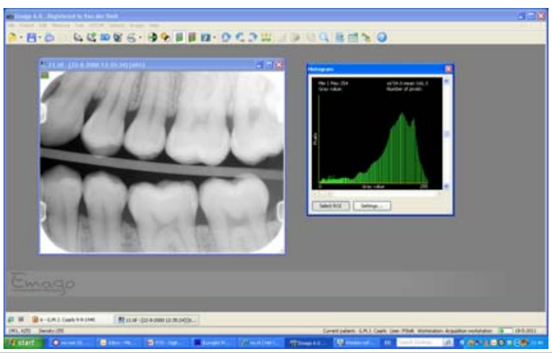
Image processing

- Is it true that image processing tools are used not very often?
- Is it true that users will not experience the benefit of image processing, depending on specific diagnostic tasks?
- If both questions are answered with a yes, how can we train clinicians in making a better use of the diagnostic advantages of digital image processing?

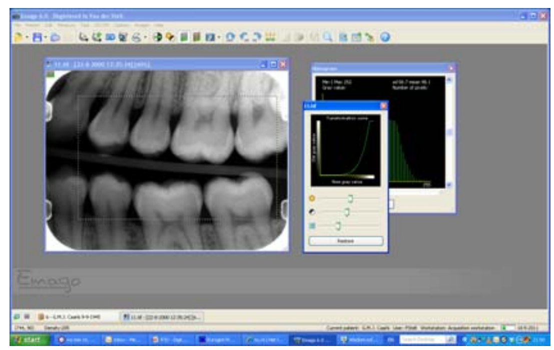
Computer guided optimization of gray value distribution



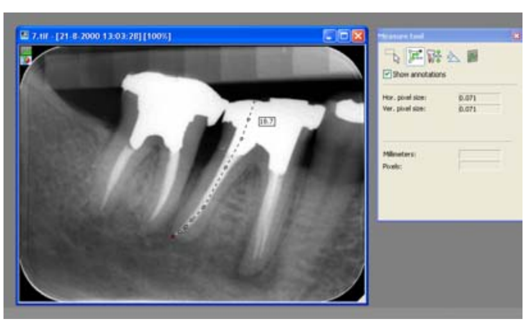
Computer guided optimization of gray value distribution



Computer guided optimization of gray value distribution



Magnification and image callibration



Magnification and image callibration

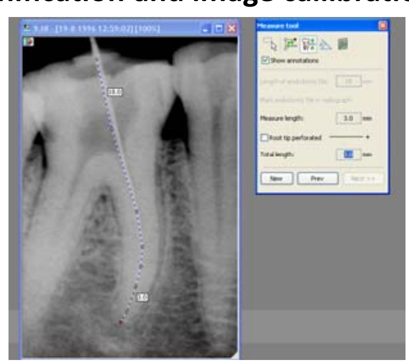


Image enhancement and filtering

Digital subtraction radiography

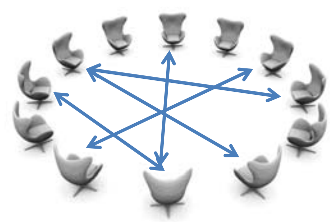
Conclusion

- Image processing tools are used not very often?

  Probably not.
- How can we train clinicians in making a better use of the diagnostic advantages of digital image processing?

  Under- and postgraduate training.

Do we really take advantage of the capabilities of digital imaging to its full extent?



Taking advantage of digital imaging

- How common are protocols for image communication and are they widely applied?
- Do dentists use digital image information as an integral component of the electronic patient record?

Image communication

- DICOM is the officially recognized standard for the exchange of image data.
- Not many manufacturers offer DICOM as a standard tool in dental imaging.
- Instead use of other *de facto* standards.

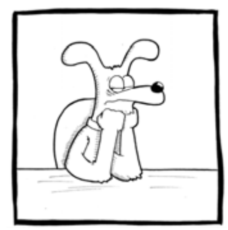
Questions to answer

- Is digital imaging seamlessly integrated into your EPR?
- Can you easily retrieve radiographs?
- Does it bother you…?

What do we decide?

Where are we?

- Digital certaonly works but not the way it was intended…
- Digital has replaced traditional imaging, but not the new capabilities are not fully used.



Time for discussion …

Standardization of diagnostic images

1. What standardization means to you

The standardization of diagnostic images may vary depending on your interest. Most of us will think of unified data format coming from various kinds of imaging equipments designed by various manufacturers.

DICOM is the most acknowledged standard for medial image data format and data exchange. DICOM is structured with the concept of the combination of object and service. Objects, some of which are named CR,CT,VL,IO, are defined depending how it was physically created. Some variations, such as multi-frame UL, functional MR, have been added to original object definitions in order to represent their special usage such as cine display or pseudo color presentation. Services have been also defined in DICOM, such as Storage, Print, MWM, MPPS, SR, etc. SOP (Service Object Pair) such as CR image Storage, IO image Print are also defined with mandatory and optional tags for correct mutual understandings of the image content.

As DICOM has responded to solve user's problems and requests, it has expanded its coverage not only the common data format but also the basic usage of the objects. The typical extension is an inclusion of consistency of displayed images. This mechanism covers physical characteristics of the display monitor such as matrix size, luminescence curve, and LUT curve to compensate it. Images can also be arranged their relative location on the monitor screen according to pre-defined format that is specified in particular tags inside the image file. One good example is a Mammography exam; images are taken and displayed in commonly known manner to radiologists. All necessary information to achieve proper display format is defined as a part of image information module of Mammography (MG).

Intra-oral (IO) images may be made in either conventional film system or CR, but in either case they are categorized as IO because of the technique it was taken. This object also has its dedicated information tags defined for IO object. And expected display format or image alignment can be recognized by the display system if proper information is included in the IO image header.

2. Other standards and guidelines

DICOM mainly defines the data format of each object, and how object is transferred. Some specialized medical societies have defined typical procedure of their exams and diagnosis. It defines how images should be taken, and how they are to be displayed and diagnosed. When we think of the flow of information and activities of related personnel through one exam, we will find there is no such big difference between chest X-ray, CT, and dental exam.

IHE (Integrating Healthcare Enterprise) has defined many flow-charts of daily medical procedures. They are called Profiles such as SWF (Scheduled Work Flow), CPI (Consistent Presentation of Images) or PDI (Portable Data for imaging). Many of these can be applied to various departments as they are defined in universal way.

ISO, SNM, HL7, and other organizations also help us define terminology such as structure of our body, or disease names.

3. Some useful web pages

DICOM home page: at MITA (Medical Imaging and Technology Alliance, Division of NEMA)

http://www.nema.org/prod/med/

Quick search for the latest DICOM modification: David Clunie's homepage

http://www.dclunie.com/dicom-status/status.html

Japanese translation of DICOM standard: at JIRA

http://www.jira-net.or.jp/dicom/index.html

IHE profiles: at IHE North America

http://www.ihe.net/

Japanese documents about IHE profiles: at IHE-Japan

http://www.ihe-j.org/index.html

4. JIRA's contribution to DICOM and to domestic societies, manufacturers

Japan Industries Association of Radiological systems (JIRA) is a registered member in DICOM Committee as a DICOM-promoting organization. JIRA collects voices from domestic users and manufacturers, and has raised many supplements and corrections in the past. JIRA also contributes in the definition and its representation mechanism of two-byte character sets in DICOM.

Standardization of diagnostic images

- How DICOM works with Dental -

Japan Industries Association of Radiological Systems (JIRA)
DICOM-Committee Chair Makoto Suzuki

preface

- This presentation is made to introduce
  - the basics of DICOM Standard which is already a de-facto standard in medical imaging industry.
  - how standards help you work smoothly in your environment.
  - Some other guidelines to standardize your work environment.

Acknowledgement
Some of Dental images were provided by
Mr. Yamamoto of Osaka University.

contents

1) What DICOM defines

2) Application of DICOM to Dental
vs. mammography

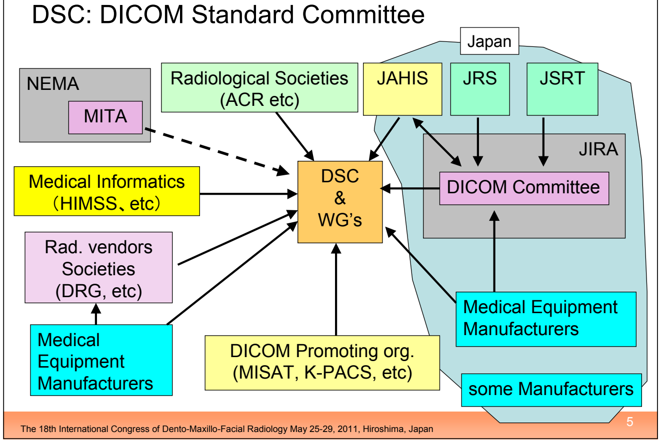
3) Other related Standards

DICOM Standard overview

- Digital Imaging and COmmunication in Medicine
- Medical equipment vendors and users world-wide contribute the progress of DICOM standard, and it is officially supported by NEMA,USA.
- Corrections and Supplements are accepted any time, and the latest version including them is issued every year as DICOM2008, DICOM2009,,,,,
- DICOM standard is written in English, and the Japanese translation is located at JIRA homepage.

DICOM Standard Contribution from Japan

DSC: DICOM Standard Committee



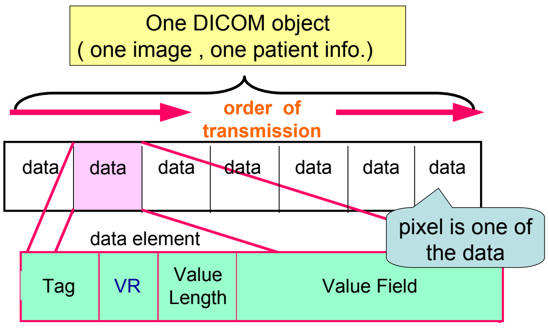
DICOM Standards Location

MITA：http://medical.nema.org/

DICOM Standards Japanese translation

JIRA Home-page http://www.jira-net.or.jp/index.htm

DICOM Standard Object structure



Patient name (0010,0010)	PN	32	Yamada^taro=山田^太郎

DICOM Standard example (MR image tags)

IMAGE STORAGE from MR to PACS

(0000,0100)	Command Field	1 0x0001 C-STORE-RQ
(0008,0005)	Specific Character Set	"¥ISO 2022 IR 87 "
(0008,0008)	Image Type	"DERIVED¥PRIMARY¥OTHER "
(0008,0016)	SOP Class UID	"1.2.840.10008.5.1.4.1.1.4 "
(0008,0018)	SOP Instance UID	"1.2.840.113701.4.2.9673.0.14415.0.1 "
(0008,0020)	Study Date	"20110527"
(0008,0030)	Study Time	"123000"
(0008,0050)	Accession Number	"201105270203451"
(0008,0060)	Modality	"MR"
(0010,0010)	Patient's Name	"緊急S222"
(0010,0020)	Patient ID	"1048010120"
(0018,0087)	Magnetic Field Strength	"0.35"
(7FE0,0010)	Pixel Data	524288Bytes

IMAGE STORAGE response from PACS

(0000,0100)	Command Field	32769 0x8001 C-STORE-RSP
(0000,0900)	Status	"0 0x0000"

DICOM Standard example (exam query tags)

MWM-SCU requests scheduled exam information

(0010,0010)	Patient's Name	0	""
(0010,0020)	Patient ID	0	""
(0010,0030)	Patient's Birth Date	0	""
(0010,0040)	Patient's Sex	0	""
(0040,0002)	Start Date	18	"20110527-20110527"
(0040,0003)	Start Time	12	"000000-235959 "

MWM-SCP returns patient information

(0010,0010)	Patient's Name	18	" testdata^inpatient"
(0010,0020)	Patient ID	10	"0000010508"
(0010,0030)	Patient's Birth Date	8	"19750520"
(0010,0040)	Patient's Sex	2	"M "
(0040,0002)	Start Date	8	"20110527"
(0040,0003)	Start Time	6	"094500"

DICOM Standard PS 3.3

- PS 3.3 defines information objects.
  - DICOM defines all activities with combination of Service and Object Pairs (SOP)
  - Defined objects are found in PS3.3 contents page.

A.1.4 Overview of the Composite IOD Module Content ... 129
A.2 COMPUTED RADIOGRAPHY IMAGE INFORMATION OBJECT DEFINITION ... 130
A.2.1 CR Image IOD Description ... 130
A.2.2 CR Image IOD Entity-Relationship Model ... 130
A.2.3 CR Image IOD Module Table ... 130
A.3 COMPUTED TOMOGRAPHY IMAGE INFORMATION OBJECT DEFINITION ... 131
A.3.1 CT Image IOD Description ... 131
A.3.2 CT image IOD Entity-Relationship Model ... 131

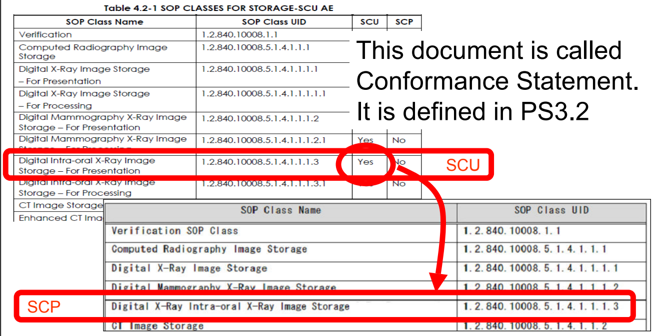
A.27 DIGITAL MAMMOGRAPHY X-RAY IMAGE INFORMATION OBJECT DEFINITION ... 166
A.27.1 Digital Mammography X-Ray Image IOD Description ... 166
A.27.2 Digital Mammography X-Ray Image IOD Module Table ... 168
A.27.3 Overlay Plane Module ... 169
A.28 DIGITAL INTRA-ORAL X-RAY IMAGE INFORMATION OBJECT DEFINITION ... 169
A.28.1 Digital Intra-oral X-Ray Image IOD Description ... 169
A.28.2 Digital Intra-oral X-Ray Image IOD Module Table ... 170
A.28.3 Overlay Plane Module ... 171

DICOM Standard PS 3.4

- PS3.4 defines Services.
  - DICOM defines all activities with combination of Service and Object (SOP)
  - Defined services are found in PS3.4 contents page.
  - Service is activated by Service Class User (SCU), and responded by Service Class Provider (SCP).
  - each SOP is numbered for easy acknowledgement. (SOP Class UID)
    - MR Image Storage : 1.2.840.10008.5.1.4.1.1.2
    - IO Image Storage : 1.2.840.10008.5.1.4.1.1.3
  - each object is numbered with unique ID (SOP Instance UID)

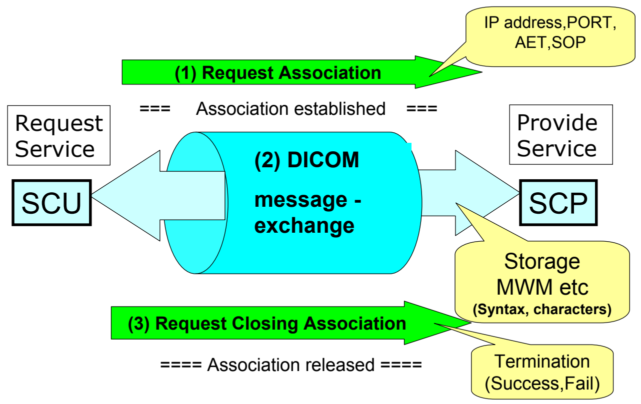
DICOM Standard — PS 3.2

- Each system needs to declare which DICOM SOP classes are supported in it.



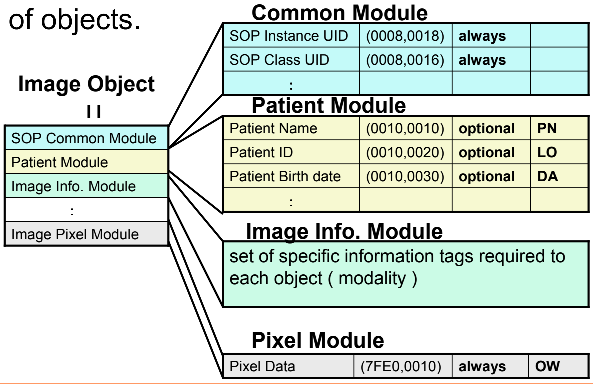
This document is called Conformance Statement.
It is defined in PS3.2

DICOM Standard — 3 steps in DICOM



DICOM Standard — Object structure

- PS3.5 defines the structure and representation of objects.



Application of DICOM — Mammo vs. Dental

- Mammography and Oral images are defined as Objects in DICOM

	Mammo images	Dental images
# of objects	2 (R/L)	32 max.(4 quadrants)
# of images	2 or 4	3 to 14
imaging method	standardized	local standard
display method	standardized	local standard
object	MG (CR)	IO (CR)

Application of DICOM — Mammo images

Info. module of MG images (Mammography)

name	tag	value (image#1)	#2	#3	#4
image type	(0008,0008)	MG	MG	MG	MG
image laterality	(0020,0062)	RIGHT	LEFT	RIGHT	LEFT
view code	(0054,0220)	yes	yes	yes	yes
>code value	(0008,0100)	R-10226	R-10226	R-10242	R-10242
>code designator	(0008,0102)	SNM3	SNM3	SNM3	SNM3
>code meaning	(0008,0104)	MLO	MLO	CC	CC

"SNM" defines how images should be taken.
It also defines how these images should be aligned on the monitor screen.

Application of DICOM — Mammo images

SNM ?

SNOMED Ver3
(Systematized Nomenclature of Medicine)

IHTSDO (International Health Terminology Standards Development Organization) maintains medical terminology with HWO.
http://www.ihtsdo.org/

Application of DICOM — Mammo images

Typical Imaging Technique: MLO & CC
Typical Display format: MLO(R/L) + CC(R/L)
Standardized by : SNM

MLO:
medio-lateral oblique
内外斜位方向

CC:
cephalad cranial
頭尾方向

Application of DICOM — Mammo images

- The method of taking and displaying mammography images is standardized.
  - same # of images per exam.
  - same imaging method (exposure angle)
  - same display format.
  - they are controlled / maintained by proper society and international standardization organization.
- DICOM can refer these external standards and make use of standardized imaging method and display format.

Application of DICOM — Mammo vs. Dental

- DICOM data structure
  - Image information module
    - CR : No tags to specify how to take and display images
      (CR is used in various exams, there is no standard)
    - MG : SNM defines how to take and display images
      And there are tags to specify these.
      (pretty much standardized exam)
    - IO : There are tags to specify these….
      but none defines how to take and display images.

Application of DICOM — Dental

Typical CR image Information tags

attribute	TAG	example
Photometric Interpretation	(0028,0004)	MONOCHROME2
kV	(0018,0060)	150
mA	(0018,1151)	80
Cassette Size	(0018,1403)	35CMX43CM

If a Intra-Oral image (IO) is taken by CR, these tags are added to the image.

name	tag	value
Positioner type	(0018,1508)	CEPHALOSTAT
image laterality	(0020,0062)	RIGHT
anatomic region sequence	(0008,2218)	11
code sequence macro		yes
>coding scheme designator	(0008,0102)	ISO 3950-1984
>primary anatomic structure seq.	(0008,2228)	11¥12¥13

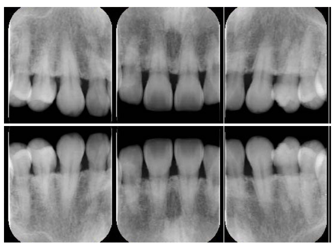
Application of DICOM — Dental

- Image Info. module contains modality-specific information. By using it, post-processing or display format can be automatically defined IF THERE IS A STANDARD and DATA IS THERE.

So, What is defined as a standard in DICOM related to DENTAL ?

Application of DICOM — Dental

If dental images are taken as CR (not IO),
the position (anatomic region resolution) will be one of RIGHT / BOTH / LEFT.
BUT WE NEED MORE RESOLUTION ! teeth by teeth



If these images are taken as CR, there is no tag to tell upper or lower teeth.

Application of DICOM Dental

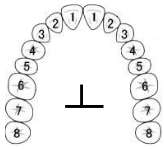
DICOM accepts teeth indexing method.

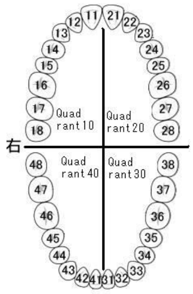
That is ISO 3950－1984.

Problem No1:

Each domain uses

local naming system.

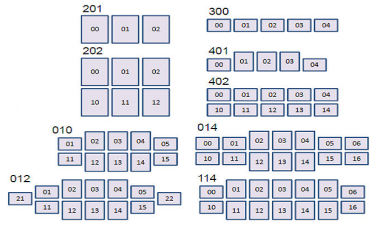




Application of DICOM Dental

Problem No2:

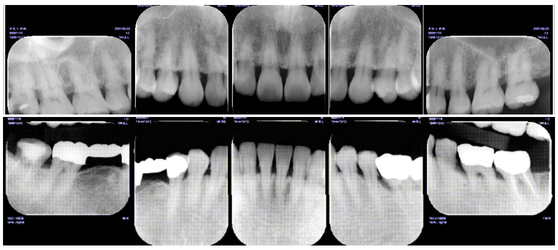
- Which image in the set covers which tooth is not standardized. (physical size , overlap, missing ones)
- Also its variety is not registered / maintained. (internationally)



Application of DICOM Dental

- what is IDEAL ?

These 10 images must align to correct position AUTOMATICALLY. (By using some tag info.)



Application of DICOM Dental

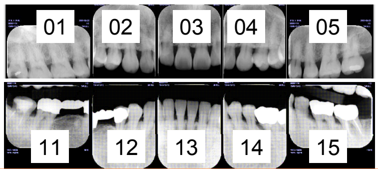
To automatically display these images in correct order, there must be some info. to tell…

(1) Which imaging method is used

10-image / 14-image / etc

(2) image index according to (1)

01-05/11-15 in 10-image method



Application of DICOM Dental

If we add some new tags to DICOM…

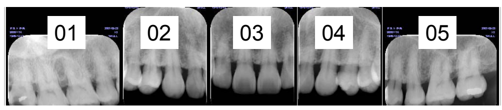
(0008,22XX) : Imaging method (10-image/14-image..)

(0008,22YY) : Image position index

(0008,2228) : Anatomic Structure Sequence

tag	data	data	data	data	data
(0008,0008)	IO	IO	IO	IO	IO
(0020,0062)	RIGHT	RIGHT	BOTH	LEFT	LEFT
(0008,2218)	yes	yes	yes	yes	yes
>(0008,22XX)	IMG10	IMG10	IMG10	IMG10	IMG10
>(0008,22YY)	01	02	03	04	05
>(0008,2228)	18¥17¥ 16¥15	15¥14¥ 13¥12	12¥11¥ 21¥22	22¥23¥ 24¥25	25¥26¥ 27¥28

Application of DICOM Dental

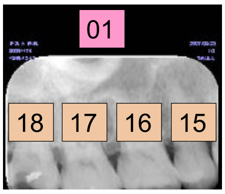


tag	data	data	data	data	data
(0008,0008)	IO	IO	IO	IO	IO
(0020,0062)	RIGHT	RIGHT	BOTH	LEFT	LEFT
(0008,2218)	yes	yes	yes	yes	yes
>(0008,22XX)	IMG10	IMG10	IMG10	IMG10	IMG10
>(0008,22YY)	01	02	03	04	05
>(0008,2228)	18¥17¥ 16¥15	15¥14¥ 13¥12	12¥11¥ 21¥22	22¥23¥ 24¥25	25¥26¥ 27¥28

Application of DICOM Dental

And if teeth index are somehow entered in
(0008,2228) Primary Anatomic Structure Sequence,
you can find which image each teeth is imaged in.
This information can be used to find/retrieve images of specific teeth.
PROBLEM : How to detect and index each teeth in an image.

tag	data
(0008,0008)	IO
(0020,0062)	RIGHT
(0008,2218)	yes
>(0008,22XX)	IMG10
>(0008,22YY)	01
>(0008,2228)	18¥17¥16¥15



Application of DICOM Dental

- We need to do these AUTOMATICALLY
  – set imaging method (10-image, 14-image,,)
  – set image index number (out of 10/14 images)
  – set tooth index number (out of 32 teeth)

  – and enable all related equipments to handle these information.
- Then all Intra-oral images will be displayed correctly on monitor. And the same tooth in previous exam can be found (retrieved).

Other related Standards IHE profile

(1) IHE : Integrating Healthcare Enterprise
- IHE is NPO from medical and manufacturers.
- IHE defines many profiles.
  (standardized relationship of related personnel (Actor) and information (Object))
- Profiles are created from practical routine work.

Some profiles can be applied to dental procedures.

・Scheduled Workflow (SWF)
・Consistent Presentation of Images (CPI)
・Portable Data for Imaging (PDI) and more

Other related Standards IHE profile

- Profiles defined by IHE are found at
  – IHE homepage http://www.ihe.net/
  – Japanese translation
    http://www.ihe-j.org/links/index.html

FIN

1) DICOM defines most of medical image format, and its communication method.
2) Dental images has wide variety of taking images, and showing them, mainly due to physical diversity. This makes it difficult to standardize the exam.
3) DICOM provides tags to arrange images on monitor, or specify each small structure.
4) DICOM can refer external standards to coordinate with them.

Thank You

Key Standards and Guidelines Impacting on Oral and Maxillofacial Radiology

Various national and international standards impact on the practice of Oral/Dental and Maxillofacial Radiology. These include standards that define the specifications for the physical machinery we use, guidelines for image format to improve the likelihood of interoperability, and also recommendations to improve safety both for the practitioners and for their clients. The purpose of this segment of the ICDMFR-Hiroshima Round Table on Digital Imaging is to help demystify the processes involved in development of rules that are largely ignored in most standard texts. Indeed, sometimes the existing standards are poorly understood or simply ignored even by researchers in our field. Such neglect can make comparisons between published works problematic. It also tends to invalidate affected studies, making it far less likely that such work will gain acceptance for publication.

Equipment Standards:

International Electrotechnical Commission (IEC):
Web Resource: http://www.iec.ch/

The International Electrotechnical Commission (IEC) was founded in 1906 and is a non-profit, non-governmental international standards organization that prepares and publishes International Standards for all electrical, electronic and related technologies – collectively known as "electrotechnology". IEC standards cover a vast range of technologies from power generation, transmission and distribution to home appliances and office equipment, semiconductors, fibre optics, batteries, solar energy, nanotechnology and marine energy as well as many others. The IEC also manages three global conformity assessment systems that certify whether equipment, system or components conform to its International Standards.

The IEC charter embraces all electrotechnologies including energy production and distribution, electronics, magnetics and electromagnetics, electroacoustics, multimedia and telecommunication, as well as associated general disciplines such as terminology and symbols, electromagnetic compatibility (by its Advisory Committee on Electromagnetic Compatibility, ACEC), measurement and performance, dependability, design and development, safety and the environment. IEC is headquartered in Geneva, Switzerland.

For technologies used in the discipline of Oral/Dental and Maxillofacial Radiology the relevant committee is IEC 86B, and most especially subcommittee 46. IEC recommendations are generally adopted by national regulatory bodies and closely followed by industry world wide.

International Organization for Standardization (ISO):
Web Resource: http://www.iso.org/iso/home.html

The International Organization for Standardization (ISO) is an international standard-setting body composed of representatives from various national standards organizations. Founded on February 23, 1947, the organization promulgates worldwide proprietary industrial and commercial standards. It has its headquarters in Geneva, Switzerland. While ISO defines itself as a non-governmental organization, its ability to set standards that often become law, either through treaties or national standards, makes it more powerful than most non-governmental organizations. In practice, ISO acts as a consortium with strong links to governments.

The standards pertaining to our discipline generally fall under either ISO TCP/215 Health Informatics or ISO TCP/106 Dentistry.

Interoperability:

Digital Imaging and Communications in Medicine (DICOM):
Web Resources: http://medical.nema.org/

DICOM (Digital Imaging and Communications in Medicine) is a standard for handling, storing, printing, and transmitting information in medical imaging. It includes a file format definition and a network communications protocol. The communication protocol is an application protocol that uses TCP/IP to communicate between systems. DICOM files can be exchanged between two entities that are capable of receiving image and patient data in DICOM format. The National Electrical Manufacturers Association (NEMA) acts as Secretariat to the DICOM Committee and holds the copyright to this standard. The Standard is maintained open source and can be downloaded free of charge in its entirety at the url provided above.

DICOM enables the integration of scanners, servers, workstations, printers, and network hardware from multiple manufacturers into a picture archiving and communication system (PACS). The different devices come with DICOM conformance statements which clearly state the DICOM classes they support. DICOM has been widely adopted by hospitals and is making inroads in smaller applications like dentists' and doctors' offices.

DICOM is known as NEMA standard PS3, and as ISO standard 12052:2006 "Health informatics - Digital imaging and communication in medicine (DICOM) including workflow and data management."

The DICOM Standard is continually being updated by introduction of new supplements and correction items. There are now 27 working groups, with Working Group 22 being specifically for Dentistry. The AAOMR, ADA and AAO are voting members of the DICOM Standards Committee.

Joint Health Level 7 International (HL7):
Web Resources: http://www.hl7.org/

Health Level Seven International (HL7) is a global authority on standards for interoperability of health information technology. Founded in 1987, Health Level Seven International (HL7) is a not-for-profit, ANSI-accredited standards developing organization dedicated to providing a comprehensive framework and related standards for the exchange, integration, sharing, and retrieval of electronic health information that supports clinical practice and the management, delivery and evaluation of health services.

Integrating the Healthcare Enterprise (IHE):
Web Resources:

IHE is an initiative by healthcare professionals and industry to improve the way computer systems in healthcare share information. In 1997, a consortium of radiologists and information technology (IT) experts formed IHE, or "Integrating the Healthcare Enterprise." IHE created and operates a process through which interoperability of health care IT systems can be improved. The group gathers case requirements, identifies available standards, and develops technical guidelines that manufacturers can implement. IHE also stages "connectathons" and "interoperability showcases" in which vendors assemble to demonstrate the interoperability of their products.

IHE is an international organization that focuses on the development of open and global IHE Integration Profiles and on the regional deployment of interoperable IT systems. Because of its limited resources, IHE concentrates on specific projects. It solicits proposals; and after surveying its members to better understand their priorities, it chooses areas to focus on.

For the discipline of Oral and Maxillofacial Radiology the most relevant IHE domains is IHE Radiology. The AAOMR is a member organization of IHE Radiology. Recently, an IHE domain for Dentistry has been initiated but is in its infancy with no profiles yet under its belt.

Radiation Measurement and Safety:

International Commission on Radiation Protection (ICRP)
Web Resource: http://www.icrp.org/

The International Commission on Radiological Protection (ICRP) is an advisory body providing recommendations and guidance on radiation protection; It was founded in 1928 by the International Congress of Radiology (ICR) and was then called the 'International X-ray and Radium Protection Committee'. Then it was restructured to better take account of uses of radiation outside the medical area, and given its present name, in 1950. ICRP is a not-for-profit organization in the United Kingdom and currently has its scientific secretariat in Ottawa, Canada.

National Council on Radiation Protection and Measurements (NCRP):
Web Resource: http://www.ncrponline.org/

The National Council on Radiation Protection and Measurements (NCRP) is a U.S. organization. It has a congressional charter under Title 36 of the United States Code, but this does not imply it has any sort of oversight or supervision from Congress; it is not a government entity. The NCRP seeks to formulate and widely disseminate information, guidance and recommendations on radiation protection and measurements which represent the consensus of leading scientific thinking. The Council is always on the alert for areas in which the development and publication of NCRP materials can make an important contribution to the public interest. The Council's mission also encompasses the responsibility to facilitate and stimulate cooperation among organizations concerned with the scientific and related aspects of radiation protection and measurements.

The AAOMR is a sponsor of the NCRP.

NCRP Report No. 145 (2003) – Radiation Protection in Dentistry - contains information about risk from traditional 2D X-ray imaging modalities used in Dentistry.

Image Gently Alliance:
Web Resource: http://www.pedrad.org/associations/5364/ig/

The Alliance for Radiation Safety in Pediatric Imaging, the Image Gently Alliance, is a coalition of health care organizations dedicated to providing safe, high quality pediatric imaging nationwide. The primary objective of the Alliance is to raise awareness in the imaging community of the need to adjust radiation dose when imaging children. The ultimate goal of the Alliance is to change practice. The AAOMR is a member organization of the Image Gently Alliance.

Image Wisely:
Web Resource: http://www.imagewisely.org/

Image Wisely is an awareness program of the American College of Radiology, the Radiological Society of North America, the American Association of Physicists in Medicine, and the American Society of Radiologic Technologists. Image Wisely's objective is to encourage practitioners to avoid unnecessary ionizing radiation scans and to use the lowest optimal radiation dose for necessary studies. Image Wisely accepts pledges from individuals for conformance with its goals, but had not expanded alliance membership beyond the founders of this principle at the time of preparation of these notes was effected.

Dr. Farman has been involved in Standards activities since the early 1990's when he participated in DICOM demonstration projects conducted during the Radiological Society of North America Annual Scientific Sessions. He has served as voting representative to the DICOM Standards Committee for more than a decade and is Founding Co-Chair of DICOM WG 22 (Dentistry). Dr. Farman is a voting member for the US Technical Advisory Group to ISO/TC 106. During his Presidency of the American Academy of Oral and Maxillofacial Radiology, that organization has joined the DICOM Standards Committee as a voting member, became a member organization of IHE-Radiology, and has joined the Image Gently Alliance. The AAOMR also sponsors the NCRP and is represented on the ADA Standards Committee on Dental Informatics. The AAOMR is actively involved at present in attempting to completely update the CDT procedure codes used in the USA for all dental radiographic and radiologic procedures.

Development of Dental PACS

Picture archiving and communication system (PACS) is an image information technology system for the transmission and storage of medical images. The hospitals with full PACS become to be filmless.

The benefits of PACS are manifold. First, hospitals can save film and chemical costs, personal costs, film storage and handling costs, etc. Second, environmental pollution is decreased without chemicals and films. Third, customer satisfaction can be achieved by improved image quality, decrease of film loss, time saving from exposure to report, improved rate of interpretation, easier preparation of teaching image files, etc.[1] In spite of the convenience and benefits of PACS, the cost of installing PACS is high. Most Korean hospitals could not afford this system easily until the reimbursement of the cost of PACS by National Health Insurance Corporation was decided. After the Korean government started to reimburse the cost of PACS, the number of hospitals installing PACS has increased rapidly. At present, all the eleven University Dental Hospitals in Korea installed full PACS.

History and Current Status of Dental PACS

The concept of PACS was first introduced by Prof. Lemke in 1979. And the first clinical PACS project was performed at Washington University and Georgetown University by the US Army in 1985. But it failed because of immature technology and lack of understanding about clinical requirements. New PACS project, Medical Diagnostic Imaging Support system (MDIS), was attempted and installed successfully at Madigan Army Medical Center in 1992.[2] This was the first filmless hospital, and this MDIS PACS model was installed at Baltimore VA Medical Center, Samsung Medical Center in Seoul and Hammersmith Hospital in London.[2] Since the late 1990s, the next generations of PACS have been successfully installed at many hospitals all around the world. With the technical progress of network, computer, storage, and monitor, the success rate of PACS was increased.

In case of dental PACS, Dove et al.[3] reported “Design and implementation of an image management and communication system for dentomaxillofacial radiology” in 1992. They pointed out that, in order to enhance the development of IMACS in dentistry, two major issues needed to be established; standards for hardware and software, and legal acceptance of radiographic images in digital format. In 1998, Chen et al.[4] reported implementation of total OMFR IMACS at school of Dentistry, National Taiwan University. They mentioned the differences between dental PACS and medical PACS. There were larger number of examinations, smaller average image size and higher resolution images required in dental PACS. They used PACS parallel to the conventional film-library system. In November 2000, ADA adopted DICOM as standard for communication of digital dental images.[5] In 2001 Okamura et al.[6] reported integration of PACS at Kyushu University Dental Hospital with RIS and HIS. Their PACS was DICOM-based system and did not involve intraoral radiography. In 2003, Gotfredsen and Wenzel[7] described a flexible PACS to handle and communicate digital image data from various radiography systems. It was self-developed PACS providing its own image data format, not DICOM-based. In 2005, Park et al.[8] reported implementation of

DICOM-based dental full PACS at Yonsei University Dental Hospital in Korea. And they pointed out the successful implementation of PACS is important because it is the first step to keep a close connection with HIS including EMR, OCS, and ERP. In 2007, Iwasaki et al.[9] reported DICOM-based dental full PACS at Tokushima University Medical and Dental Hospital with development of a hanging protocol for displaying digital dental images. In 2009, Nair et al.[10] described enterprise-wide implementation of digital radiography at University of Florida Dental Healthcare System. They mentioned that the unique challenges to implementation of PACS in dentistry were as follows: use of high-resolution small area sensors, unique hanging protocols, task-specific post-processing of images, use of CBCT in dentistry, inability to bridge to specialty-specific software, digital images taken by students needed to be evaluated by faculty before approval, and need to integrate seamlessly with medical system.

In Korea, the first large-scale PACS was installed at Samsung Medical Center in 1994. Since that successful installation, great diffusion of partial and mini-PACS had occurred, but not full PACS. At the end of the year 1997, there was serious economic crisis in Korea. We had to import every single film because there is no Korean company producing x-ray films. On account of the shortage of US dollars and rise in exchange rate, imported film cost had rapidly increased. In November 1999, the Korean Government decided to enforce the medical insurance reimbursement program for full PACS. It became a turning point for a rapid growth in filmless PACS market. In 2001, Korean Society of PACS (now named Korean Society of Imaging Informatics in Medicine) set “Guidelines for filmless PACS for medical insurance reimbursement.”[11] Since then, large and small hospitals have installed PACS competitively. 1191 units of PACS were installed in Korea, including 56 units (127 %) at 44 tertiary hospitals and 289 units (106 %) at 272 general hospitals. It is presumed that the reason why the percentages exceed 100% is because some hospitals have two or more PACS units. Now all the University Hospitals and general hospitals use full PACS in Korea.

The first full dental PACS was installed at Wonkwang University Dental Hospital on November 2002, followed by Seoul National University Dental Hospital on January 2003. Now all the eleven University Dental Hospitals use full PACS. The number of dental unit chairs in each University Dental Hospital varies from 60 to 280. And the number of computers connecting to PACS server ranges from 55 to 300.

Almost all the University Dental Hospitals have CR imaging units for extraoral radiography; four Kodak, four Fuji, and two Agfa CR units. And also they have DR imaging units for extraoral radiography. For occlusal radiography, most hospitals have Kodak or Orex CR imaging units. For periapical radiography, all the hospitals have DR sensors. There are three hospitals which do not involve occlusal radiography in dental PACS. All the hospitals have medical CT and/or CBCT units. Hospitals which involve ultrasound scan image are four. Also, hospitals which involve photo image are four. However, there is none which involves microscopic image.

Dental PACS in all the University Dental Hospitals are DICOM-based and integrated with Hospital Information System (HIS)/ Radiology Information System (RIS)/ Order Communication System (OCS). Dental PACS coupled with Electronic Medical Record (EMR) were six. All of them are used for primary diagnosis, not for reference display only.

Almost all of them have one or more diagnostic display systems of one low-resolution color monitor combined with two 5 mega pixel, high-resolution gray-scale monitors. It is requisite to equip more than one of those diagnostic display systems according to “Guidelines for filmless PACS for medical insurance reimbursement.” The type of clinical display monitor was mainly 17” color LCD monitor.

Basic Technology of PACS

PACS is comprised of four elements, which are image acquisition system, i.e., computed radiography (CR), digital radiography (DR), computed tomography (CT), magnetic resonance imaging (MRI), DICOM gateway, and so on; database and storage system; distribution network system; and image display and output system.

Workstation Monitors[12]
- ✓ CRTs and LCDs
- ✓ Resolution
- ✓ Color versus gray scale
- ✓ Number of monitors
- ✓ Quality assurance

Networks[12]
- ✓ Network elements
- ✓ Types of networks
- ✓ Bandwidth
- ✓ Security

Storage[12]
- ✓ Advantages of different media
- ✓ Online versus off line
- ✓ Amount of storage
- ✓ Redundancy

Future Perspectives of Dental PACS

PACS provides windows to the “all-digital hospital.” By integrating HIS/RIS/EMR and pathologic imaging DB, PACS will be an excellent and powerful information source for imaging research and education. Furthermore, web PACS allowing access to electronic patient records through internet will be predominated. Nowadays web PACS is partially used for specific purposes.[13] To make widespread use of it, high levels of network security should be established first.
With rapidly increasing use of smart phone and/or tablet PC, mobile PACS is expected to become commercial in the market. “Mobile PACS system approval guideline” was made by Korea Food & Drug Administration this year. With the use of mobile PACS, the ubiquitous healthcare will become more feasible.
In addition, through embedding computer-aided interpretation technology in PACS, improvement in a radiologist’s interpretation and even automated diagnosis using artificial intelligence will come true. Also, through embedding 3D imaging technology, image-guided

treatment in PACS will be widely diffused.

References
1. Choi HS. The evolution of filmless PACS in Korea. J Korean Soc PACS 2002; 8:69-76
2. Kim JH. PACS. In: Korean Society of Medical Informatics. Health Informatics. Seoul: Hyunmoon Sa; 1999. p.463-77
3. Dove SB, McDavid WD, Welander U, Tronje G, Wilcox CD. Design and implementation of an image management and communications system (IMACS) for dentomaxillofacial radiology. Dentomaxillofac Radiol 1992; 21:216-21.
4. Chen SK, Yu KM, Chen RS, Hsieh CC. Implementation of an oral and maxillofacial radiology image management and communication system. Dentomaxillofac Radiol 1998; 27:358-62
5. Farman AG. Applying DICOM to dentistry. J Digit Imaging 2005; 18: 23-7
6. Okamura K, Tanaka T, Yoshiura K, Tokumori K, Yuasa K, Kanda S. Integration of a picture archiving and communication system with videocapture and computed radiography in a dental hospital. Dentomaxillofac Radiol 2001; 30:172-8
7. Gotfredsen E, Wenzel A. Integration of multiple direct digital imaging sources in a picture archiving and communication system (PACS). Dentomaxillofac Radiol 2003; 32:337-42
8. Park H, Jeong HK, Kim KD, Park CS. A planning for clinical application of dental full PACS system in dental general hospital. J Korean Soc PACS 2005; 11:1-10
9. Iwasaki H, Honda E, Nishitani H, Takahashi H, Yamamoto Y, Ooguro T, et al. Hanging protocol and viewers for a dental full picture archiving and communication system (PACS). Dentomaxillofac Radiol 2007; 36:285-95
10. Nair MK, Pettigrew JC, Loomis JS, Bates RE, Kostewicz S, Robinson B, et al. Enterprise-wide implementation of digital radiography in oral and maxillofacial imaging: The University of Florida Dentistry System. J Digit Imaging 2009; 22(3):232-41
11. 2001 PACS Guideline [homepage on the Internet]. Seoul: Korean Society of Imaging Informatics in Medicine; c1994-2004 [updated 2005 Jan 6; cited 2011 April]. Available from: http://www.ksiim.org
12. Branstetter BF. Basics of imaging informatics: Part 1. Radiology 2007; 243:656-667
13. Kim JH, Cha SJ, Kim HJ. Development of security guidelines for web PACS. J Korean Soc Imaging Inform Med 2007; 13:40-6

Yoshihiko Hayakawa
(Kitami Institute of Technology, Japan)

ICDMFR Hiroshima 2011

Dental Mapping and Query-Retrieve

1. Introduction, Approved New Work Item

Japanese Task Group of the Japanese Society for Oral and Maxillofacial Radiology (JSOMR) works on the project of "Dental Mapping and Query-Retrieve." This is an approved work item of DICOM Working Group 22 (Dentistry). The project would utilize the coding of teeth to create x-ray charts for mapping and viewing intraoral radiographs. An interoperable solution is necessitated in dental practice.

The solution to differentiate parallel, bisecting, bitewing, occlusal, apex-projection and de-centering techniques is necessary. It's necessary to develop the method to denote which teeth are present in a given intra-oral radiograph on a given position within a structured display. The procedure for the query-retrieve of images containing specific teeth would be developed. The present progress of the solution would like to be shown.

"Dental Mapping and Query-Retrieve" was approved as a new work item by DICOM Standards Committee (main Committee) at October 2010. We prepared the new work item proposal at Aug. and Sep. 2010 and submitted to the meeting in Rio de Janeiro, Brazil.
In the minute of the DICOM Standards Committee (main Committee), the approval is written as follows;

Proposed Work Items

Three new work-item requests were submitted for Committee approval. Each was posted at least two weeks prior to the meeting. Following due deliberations, the Committee responded as follows:

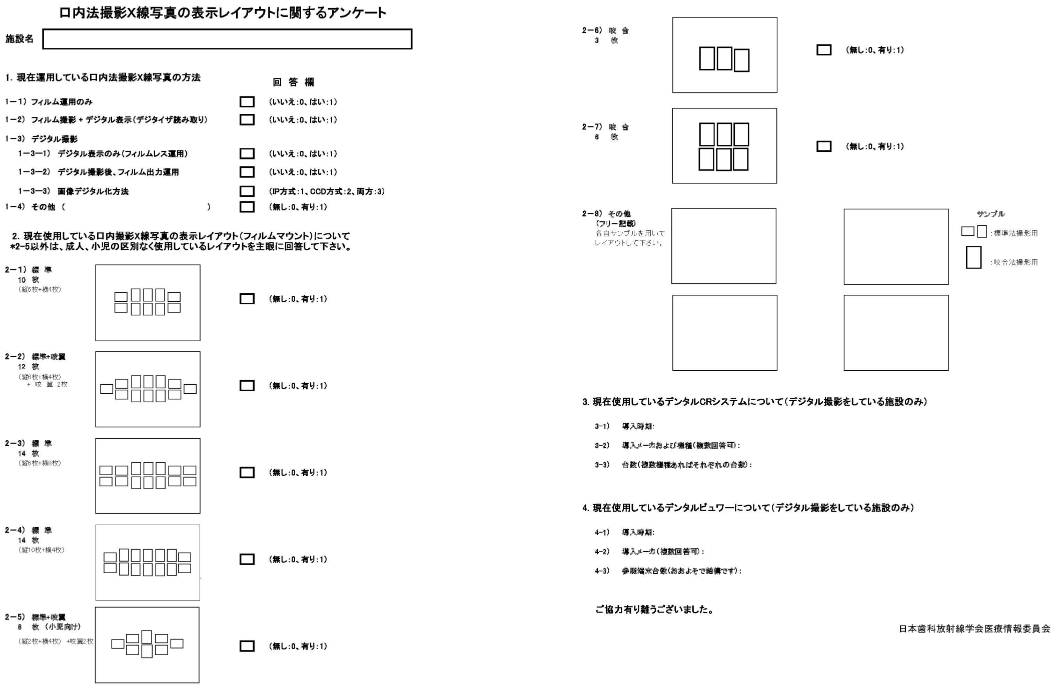
Number	WG	Topic	Result
2010-10-B	22	Dental Mapping and Query-Retrieve	Approved.

(Two other topics are omitted.)

2. Survey on the Present Status at University Dental Hospitals in Japan

In the circumstances we carried out the survey of display mapping and viewing solution for intraoral radiographs in university dental hospitals to explore the present solution.

The Task Group sent the questionnaire on display formats, which are practically used at dental school hospitals in Japan, to 80 representatives of JSOMR using the mailing list, jsomr-daigiin@umin.ac.jp (JSOMR-daigiin-ML) at Dec. 10, 2010. We thought it was effective method to send the questionnaire to all 29 university dental hospitals. We indicated typical patterns which are supposed to be used and asked whether each hospital uses it or not. And we request to indicate exceptional patterns.



口内法撮影X線写真の表示レイアウトに関するアンケート

施設名

1. 現在運用している口内法撮影X線写真の方法　　回答欄

1−1） フィルム運用のみ　（いいえ：0、はい：1）
1−2） フィルム撮影 + デジタル表示（デジタイザ読み取り）　（いいえ：0、はい：1）
1−3） デジタル撮影
1−3−1） デジタル表示のみ（フィルムレス運用）　（いいえ：0、はい：1）
1−3−2） デジタル撮影後、フィルム出力運用　（いいえ：0、はい：1）
1−3−3） 画像デジタル化方法　（IP方式：1、CCD方式：2、両方：3）
1−4） その他（　　）　（無し：0、有り：1）

2. 現在使用している口内撮影X線写真の表示レイアウト（フィルムマウント）について
*2−5以外は、成人、小児の区別なく使用しているレイアウトを主眼に回答して下さい。

2−1） 標準 10 枚（縦6枚+横4枚）　（無し：0、有り：1）
2−2） 標準+咬翼 12 枚（縦6枚+横4枚） + 咬翼 2枚　（無し：0、有り：1）
2−3） 標準 14 枚（縦6枚+横8枚）　（無し：0、有り：1）
2−4） 標準 14 枚（縦10枚+横4枚）　（無し：0、有り：1）
2−5） 標準+咬翼 8 枚（小児向け）（縦2枚+横4枚） +咬翼2枚　（無し：0、有り：1）
2−6） 咬合 3 枚　（無し：0、有り：1）
2−7） 咬合 6 枚　（無し：0、有り：1）
2−8） その他（フリー記載） 各自サンプルを用いてレイアウトして下さい。
サンプル
：標準法撮影用
：咬合法撮影用

3. 現在使用しているデンタルCRシステムについて（デジタル撮影をしている施設のみ）
3−1） 導入時期：
3−2） 導入メーカおよび機種（複数回答可）：
3−3） 台数（複数機種あればそれぞれの台数）：

4. 現在使用しているデンタルビュワーについて（デジタル撮影をしている施設のみ）
4−1） 導入時期：
4−2） 導入メーカ（複数回答可）：
4−3） 参照端末台数（おおよそで結構です）：

ご協力有り難うございました。

日本歯科放射線学会医療情報委員会

The Questionnaire (written in Japanese) sent to 29 university dental hospitals in Japan

The questionnaire contents were divided into four parts:

1. Currently used methods for image acquisition and displaying for intraoral radiography
   Image acquisition: either analogue film or digital sensor (either CR or DR)
   Digital sensor: CR (photo-stimulable imaging plate system – computed radiography)
   Digital sensor: DR (either CCD- or CMOS-based sensor – digital radiography)
2. Currently used display format patterns (or mounting layouts for films) for intraoral radiography
   We arranged for contributors to answer easily by the alternative, yes or no, for common format patterns we supposed. Also we provided a space for writing exceptions.
3. Currently used dental CR system(s). Please answer the trade name(s) in market. (only institutions taking digital acquisition)
4. Currently used dental image viewer(s). Please answer the trade name(s) in market. (only institutions taking digital acquisition)

We received 21 replies in 29 university dental hospitals until the end of Dec. 2010. The collection rate was 74 percent. The short summary of Questionnaire #1 and #2 are as follows;

1. Currently used methods for image acquisition and displaying for intraoral radiography
   Image acquisition by analogue film: 10
   Image acquisition by digital sensor: 11

2. Currently used display format patterns (or mounting layouts for films) for intraoral radiography

The number of institutes where each display format pattern (or mounting layout for films) are as follows; (numbers in parentheses are results from institutions taking digital acquisition.

1) 10 standard intraoral images (films): 11 (9)
2) 10 standard intraoral images (films) + 2 bitewing radiographs: 2 (2)
3) 14 standard intraoral images (films) (6 portrait + 8 landscape styles): 13 (6)
4) 14 standard intraoral images (films) (10 portrait + 4 landscape styles): 0 (0)
5) 6 standard intraoral images (films) + 2 bitewing radiographs (pedodontic): 0 (0)
6) 3 occlusal images (films): 3 (2)
7) 6 occlusal images (films): 3 (3)

Additional six format (layout) patterns are indicated in a space for writing exceptions. Each pattern is employed at one institute in 21 university dental hospitals.

Extra 1: 6 standard intraoral images (films) (pedodontic): 1 (0)
Extra 2: 14 standard intraoral images (films) (6 portrait + 8 landscape styles) + 4 bitewing radiographs: 1 (0)
Extra 3: 6 standard intraoral images (films) (6 landscape styles) + 2 bitewing radiographs: 1 (1)
Extra 4: 1 occlusal image (film): 1 (0)
Extra 5: 2 occlusal images (films), vertical tandem shape : 1 (0)
Extra 6: 2 occlusal images (films), horizontal shape: 1 (0)

Only Extra #3 is employed at an institution taking digital acquisition.

3. Currently used dental CR system(s)

4. Currently used dental image viewer(s)

I do not indicate the results of Questionnaire #3 and #4. But, digital acquisition systems and viewing software systems were employed in 11 university dental hospitals after 2006.

The survey showed the display mapping and format patterns of intraoral radiographs, which are practically used at dental school hospitals in Japan, in Dec. 2010. Even if we focused on only 11 institutions taking digital acquisition systems, they carried out their operations in their ways. But only a finite number of templates are necessitated in university dental hospitals in Japan.

In the circumstances the survey results showed the display formats which are necessitated as mapping and viewing solutions by university dental hospitals in Japan. The listing of them are as follows;.

Cases of standard intraoral radiographs:

10 standard intraoral images (films)
14 standard intraoral images (films) (6 portrait + 8 landscape styles)

Case of standard intraoral radiographs plus bitewing radiographs

10 standard intraoral images (films) + 2 bitewing radiographs

This format is employed at 2 institutions taking digital acquisition and can be applicable to full-mouth survey examinations for children as same as three other formats;

6 standard intraoral images (films) (pedodontic)

6 standard intraoral images (films) + 2 bitewing radiographs (pedodontic)

6 standard intraoral images (films) (6 landscape styles) + 2 bitewing radiographs

Each institution takes individual alternative for full–mouth survey examinations for children.

Cases of occlusal radiographs:

3 occlusal images (films) and 6 occlusal images (films)

These two formats can include others indicated in extras (Extra #4, #5 and #6).

3. Proposal of Dental Mapping and Query-Retrieve

Our proposal to the DICOM Standards Committee is to define specific examination codes (DICOM tags) for intra-oral radiography techniques and the relationship between tooth/teeth group and display disposition, and to provide a solution for the query-retrieve. A means to specify specific display format templates is proposed.

Due to the results of the survey, a finite number of templates which are necessitated not only in university dental hospitals in Japan but also in the world might be achieved by adding tags for designation of specific displaying templates. A means of defining the relationship between tooth/teeth group and the disposition in templates would be sought. This is a basis for achieving dental query-retrieve for intraoral radiographs on any given template.

The Task Group develops the mapping, viewing and query-retrieve procedures. We will make clear our proposal content as the new work item at next Working Group 22 meeting in Berlin, Germany, June 25, 2011.

References

1. DICOM Standards Committee, Working Group 22.
   Website: http://medical.nema.org/DICOM/minutes/WG-22/
2. Minutes of DICOM Standards Committee (main Committee) at The DICOM 2010 International Conference & Seminar.
   Website: http://medical.nema.org/Dicom/minutes/Committee/2010/2010-10/
   File: DICOM_2010-10-12_Min.doc