Tomographie volumique à faisceau conique

Cone-beam CT (CBCT)

Philippe CLAPUYT
Radiologie pédiatrique
Cliniques universitaires saint-Luc

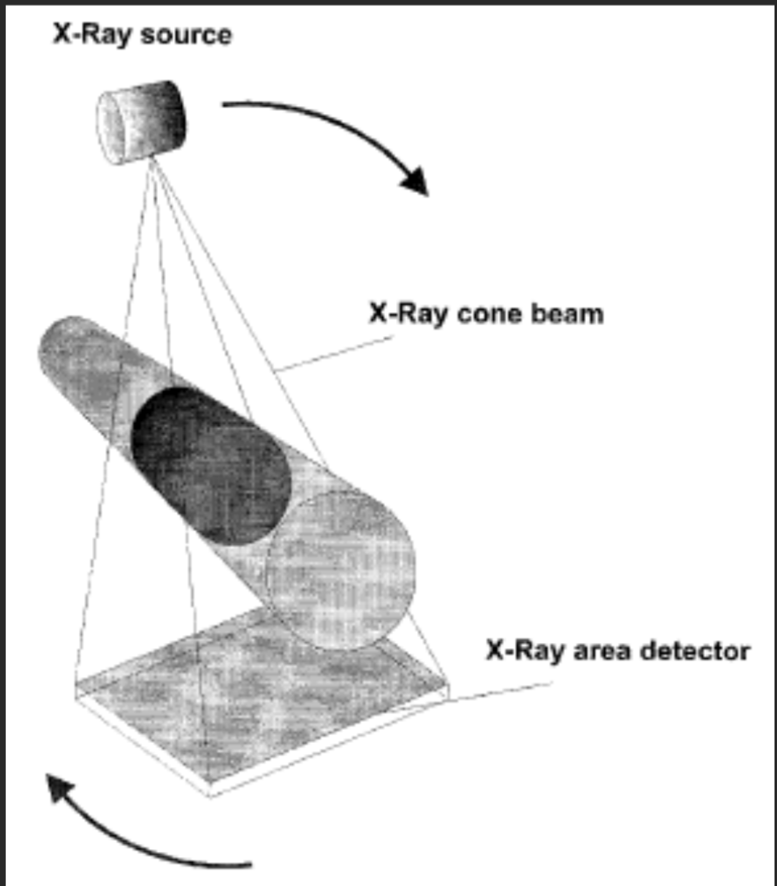
De quoi s'agit-il ?

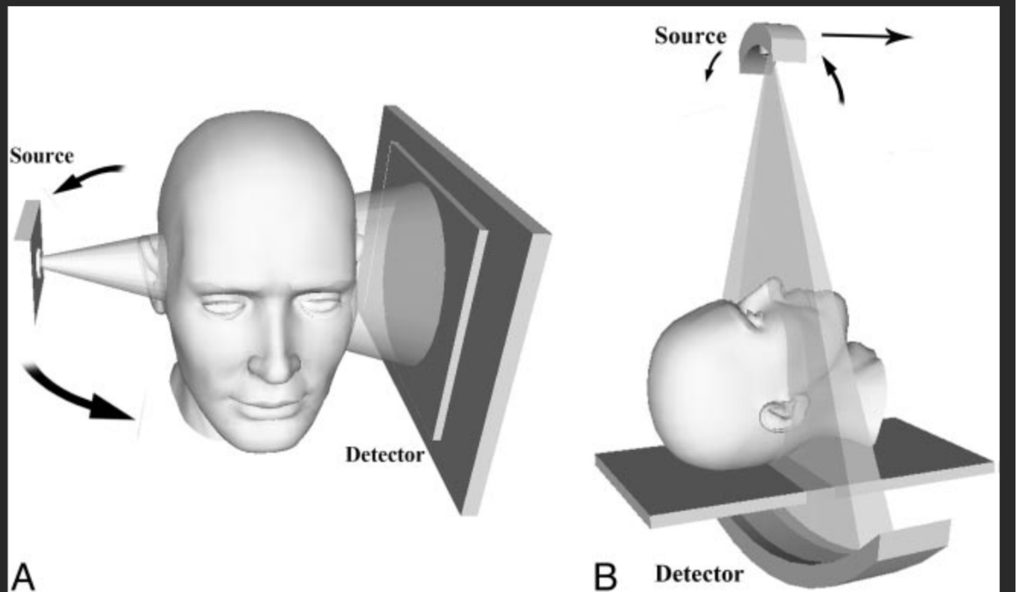
- technique d'imagerie médicale
- utilisation de RX
- sphère maxillo-faciale
  - dents, maxillaires, ATM, sinus,…
- autres cibles:
  - orthopédie, vasculaire – interventionnel,…?

Comment cela fonctionne-t-il ?

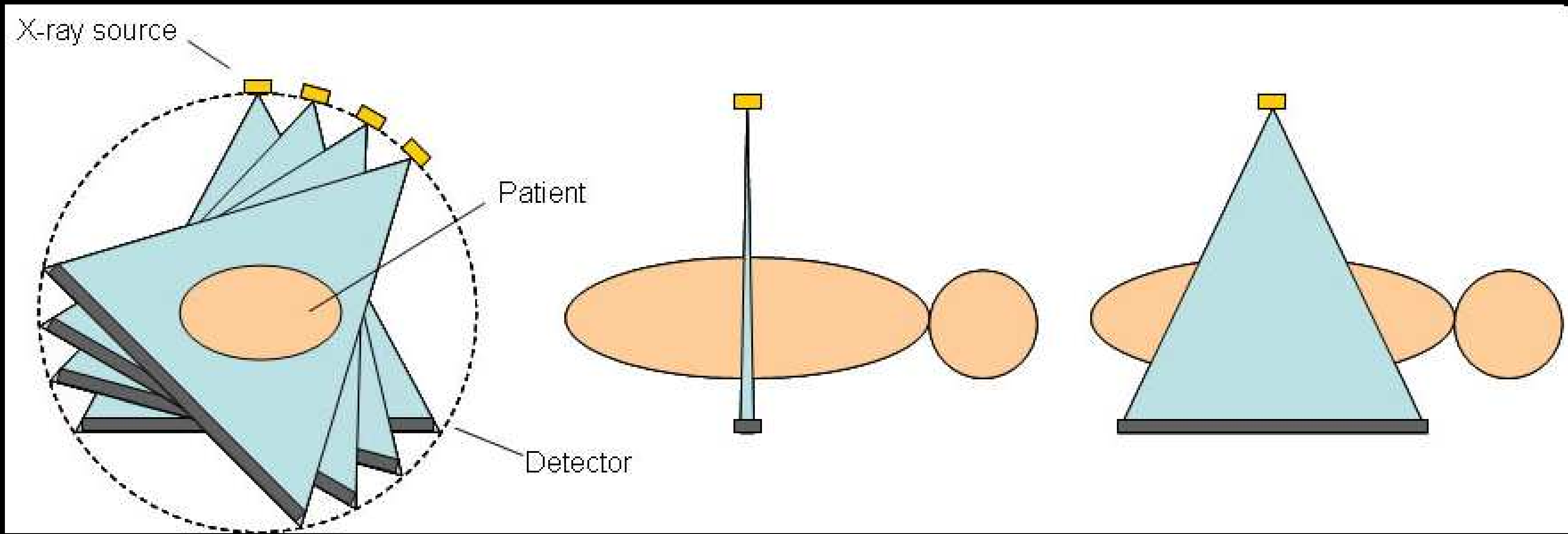
- source focale de RX
- détecteur plan (sélénium,...)
- rotation synchrone à 360°
- paramètres variables du courant (kV, mA)
- temps de rotation variable (msec.)
- champ de vue (FOV) variable
- matrice variable
- reconstructions 2D et 3D par logiciel

Comment cela fonctionne-t-il ?





Comment cela fonctionne-t-il ?





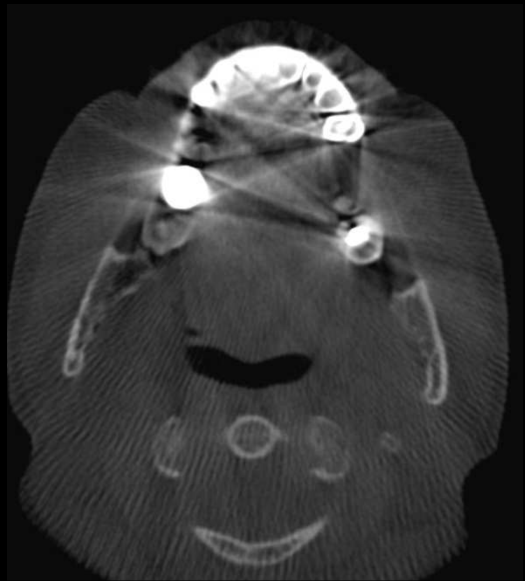
i-CAT Features

Functionality	Easy-to-operate push button controls
Low Radiation Dose*	Best image quality with less radiation to the patient Less than ½ the dose of a full mouth series NEW low dose settings for follow-up scans and children 36 - 74 µSv
Sensor Technology	Amorphous Silicon Flat Panel Sensor 16,384 shades of gray Best signal to noise ratio for clearer images Optional Extended Field of View with adjustable sensor to capture: - Landscape: Full resolution and detail obtained for smaller fields of view - Portrait: Captures Extended Field of View data
Software	Streamlined for Dental Workflow Free i-CATVision™ for unlimited networking and sharing DICOM 3 compatible output for sharing with third party applications Automatic Pan and Ceph reconstruction NEW practice management interface available with a growing list of providers DICOM functionality/PACS interface Automatic nerve canal estimation
Reporting	Available in i-CATVision™
Design	New clean design for aesthetics and ergonomics Sturdy and stable chair/head support mechanism – reduces patient movement and optimizes image quality Small in-office footprint
Support	Superior Customer Support – Technicians, Training, Marketing and Strongest R&D

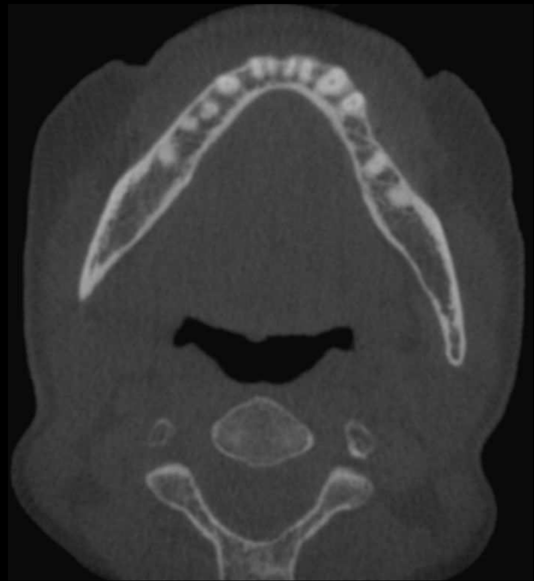
I-CAT Specifications

Sensor Type	Flat panel 20 cm x 25 cm
Grayscale Resolution	14 Bit
Voxel Size	.4 mm, .3 mm, .25 mm, .2 mm, .125 mm
Collimation	Automatic
Scan Time	5, 8.9 or 26.9 seconds
Exposure Type	Pulsed
Effective Dose*	36 - 74 µSv
Field of View	Standard Scan: 4, 6, 8, 10, 13 cm height 16 cm diameter Extended Field of View: (Cephalometric): 17 cm height 23 cm diameter
Reconstruction Shape	Cylinder
Typical Reconstruction Time	Less than 30 seconds
Typical File Size	Less than 50 MB
Sharing Software	Included
Unit Size	48" (w) x 69.5" (h) x 36.37" (d)

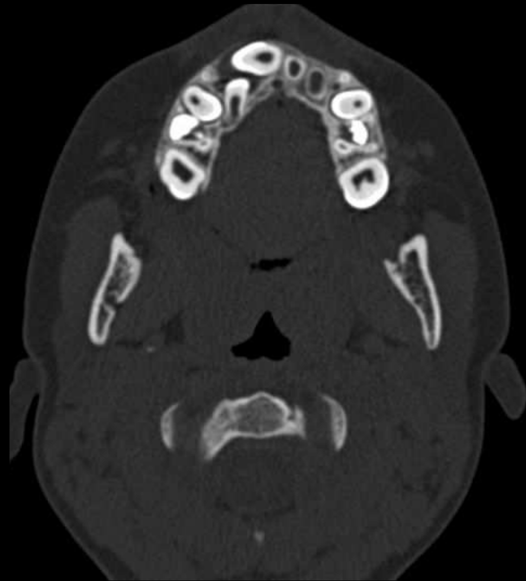
*Based on ICRP publication 60: Recommendations of the ICRP



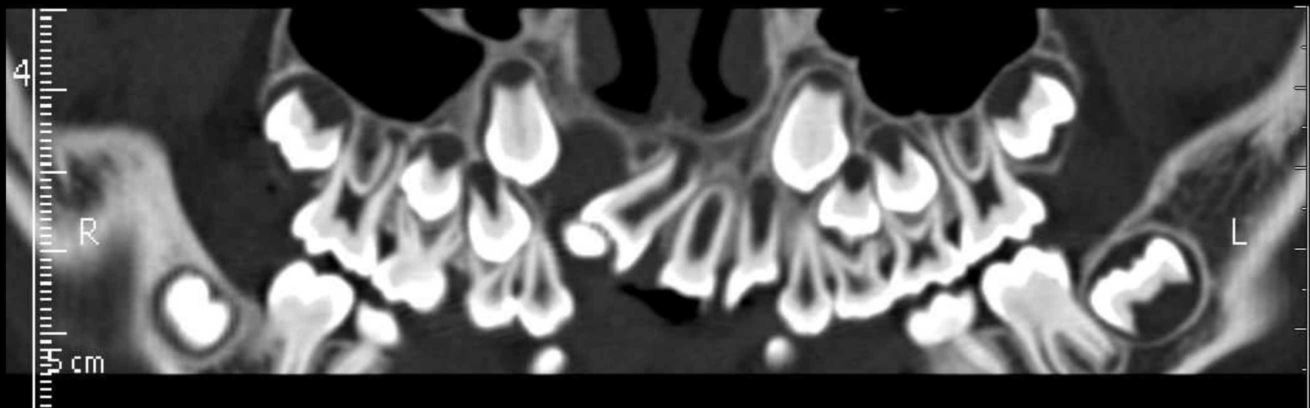
CBCT



CBCT

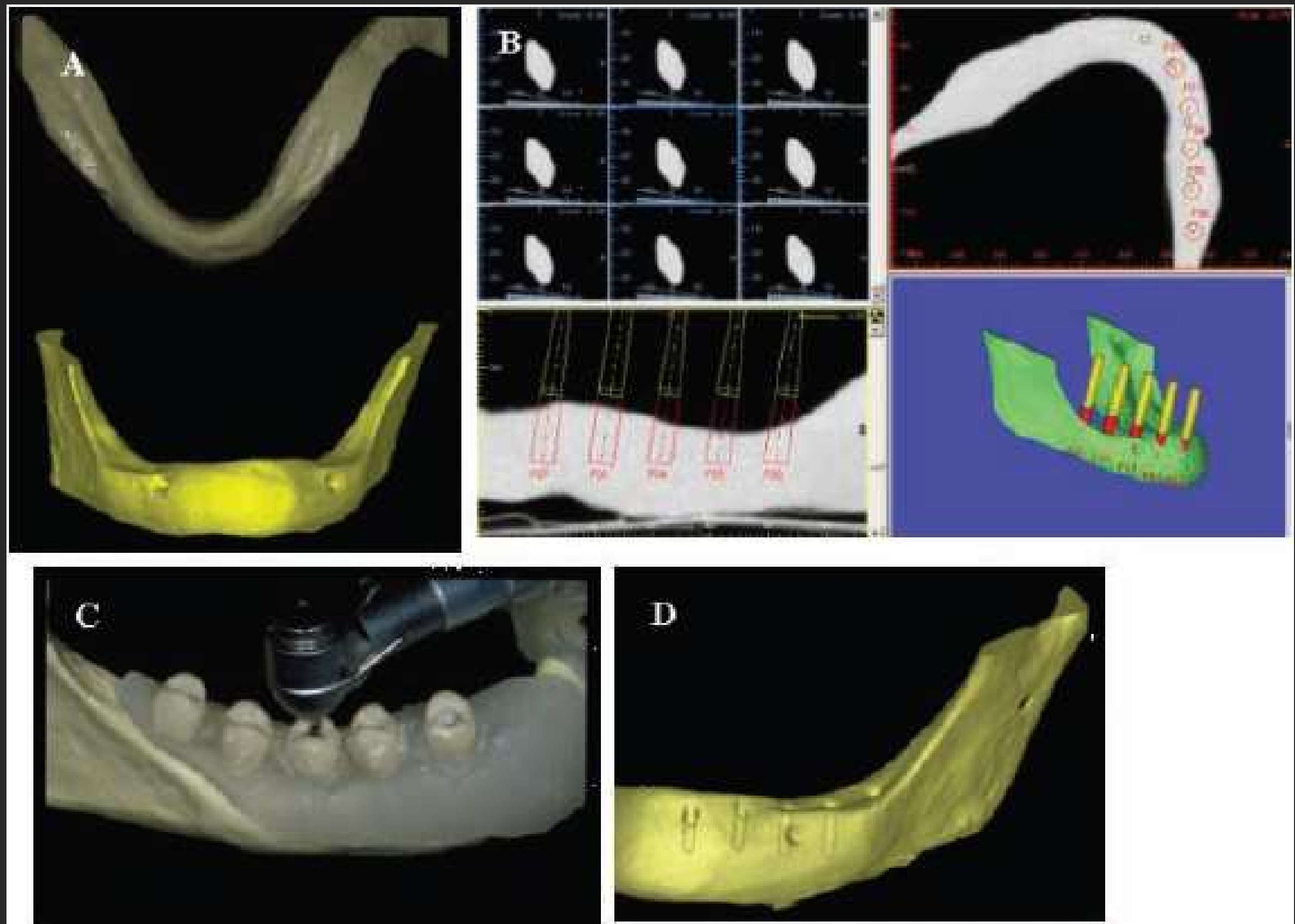


TDM



TDM

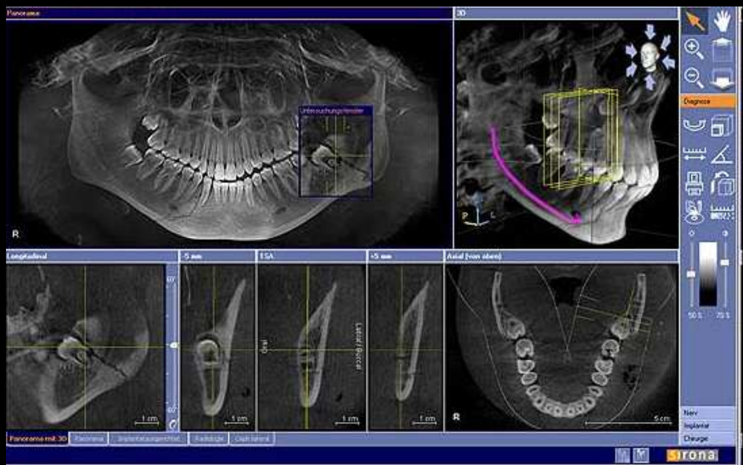
Quelle utilité ?



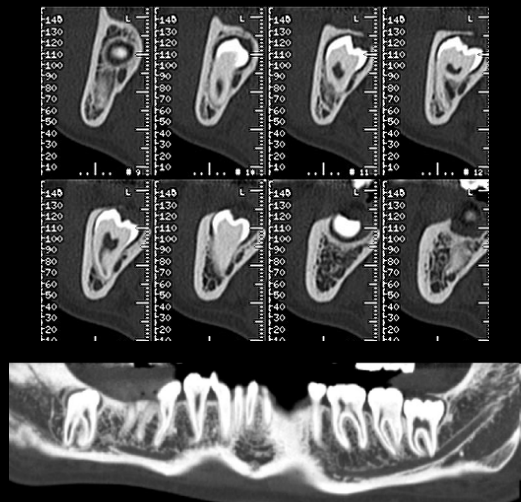
! faible résolution en contraste !

cliché intra-oral

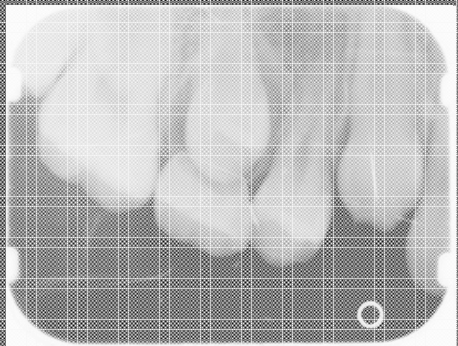
orthopantomogramme



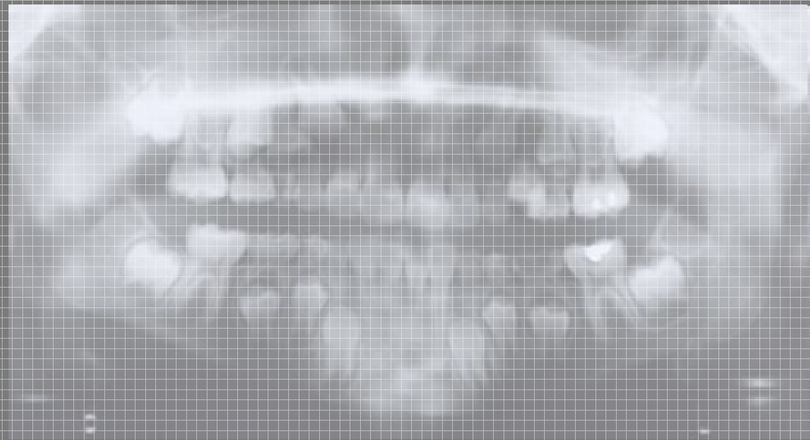
cone-beam CT



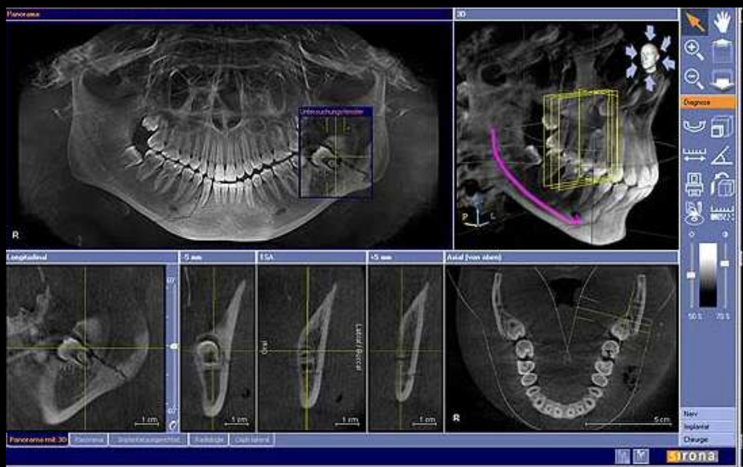
TDM hélico. (dentascan)



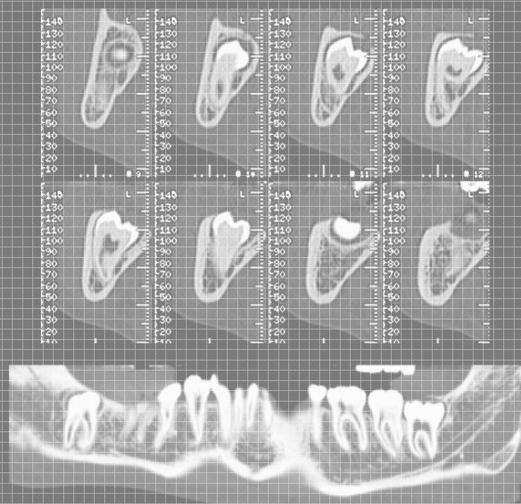
cliché intra-oral



orthopantomogramme



cone-beam CT



TDM hélico. (dentascan)

Avantages de la technique

- *« Low cost »*
  - CBCT: 250 000 €
  - TDM: 1 000 000 €
- *« Easy accessibility »*
  - au cabinet…!?
- *« Low radiation »*
  - comparé aux portiques de détection des aéroports!!

Int. J. Oral Maxillofac. Surg. 2009; 38: 609–625
doi:10.1016/j.ijom.2009.02.028, available online at http://www.sciencedirect.com

International Journal of
Oral & Maxillofacial Surgery

Invited Review Paper

Imaging

Cone-beam computerized tomography (CBCT) imaging of the oral and maxillofacial region: A systematic review of the literature

W. De Vos[1], J. Casselman[2,3], G. R. J. Swennen[1,3]

[1]Division of Maxillo-Facial Surgery, Department of Surgery, General Hospital St-Jan Bruges, Ruddershove 10, 8000 Bruges, Belgium; [2]Department of Radiology and Medical Imaging, General Hospital St-Jan Bruges, Ruddershove 10, 8000 Bruges, Belgium; [3]3-D Facial Imaging Research Group, (3-D FIRG), GH St-Jan, Bruges and Radboud University, Nijmegen, 3-D FIRG, Ruddershove 10, 8000 Bruges, Belgium

W. De Vos, J. Casselman, G. R. J. Swennen: Cone-beam computerized tomography (CBCT) imaging of the oral and maxillofacial region: A systematic review of the literature. Int. J. Oral Maxillofac. Surg. 2009; 38: 609–625.

W. De Vos and al. Int. J. Oral Maxillofac. Surg. (2009) *177/380 publ.*

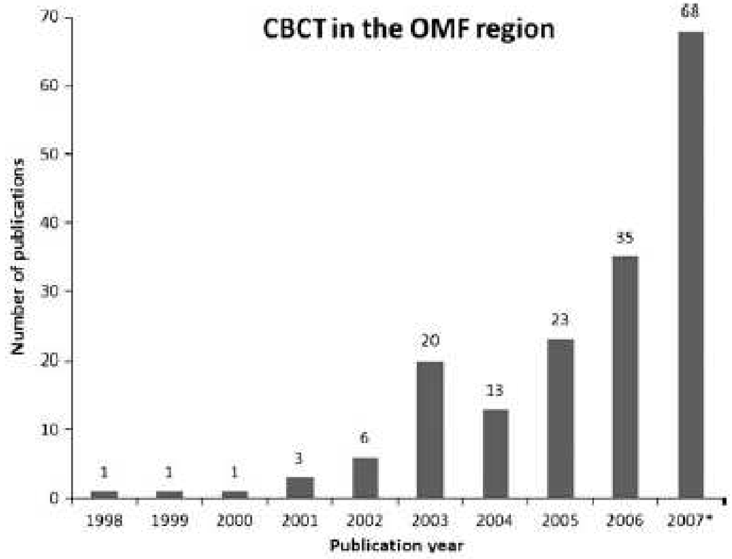


Fig. 1. Distribution of published articles on CBCT in the OMF region yielded by the PubMed search (National Library of medicine, NCBI; revised 1 December 2007). * Publications until 1 December 2007.

Table 10. Minimal set of parameters for OMF CBCT scanners recommended for future studies based on the results of this systematic review.

Manufacturer	trade name, company, city, country, website
Tube voltage	killovolt (kV)
Tube current	milli-ampere (mA)
Tube current x Exposure time	milli-ampere x seconds (mAs)
Grayscale depth	bit
Exposure time	seconds (s)
Scan time	seconds (s)
Radiation source	pulsed/not pulsed
Rotation	degree (°)
Projections per rotation	number (n)
Detector type	type
Detector size	cm
Field of view (FOV)	cm x cm
Voxel size (x,y,z)	mm^3
Scanned volume dimensions	cm x cm x cm
Matrix (pixel set)	pixel x pixel
Patient positioning	supine/seated/standing
Rotation centre to focal spot	mm
Data output	DICOM(+version)/JPG/TIFF/BMP
Radiation dose*	milli-sievert (mSv) or micro-sievert (μSv)

* ICRP version used to calculate the radiation dose should be mentioned.

W. De Vos and al. Int. J. Oral Maxillofac. Surg. (2009)

Dose délivrée

$$Dose = kV^2 \times I \times t/d^2$$

- kV = tension (ddp) du courant
- I = intensité du courant
- t = temps (s.)
- d = distance foyer-tube (m.)

DOSE ABSORBEE - Gray (Gy)

- rayonnements ionisants absorbés dans la matière avec perte d'énergie
- effet biologique du rayon f(énergie absorbée)
- dose absorbée en point P
  - $D_P = dE / dm$
  - **1 Gy = 1J / kg**
  - (1 Gy = 100 rad)

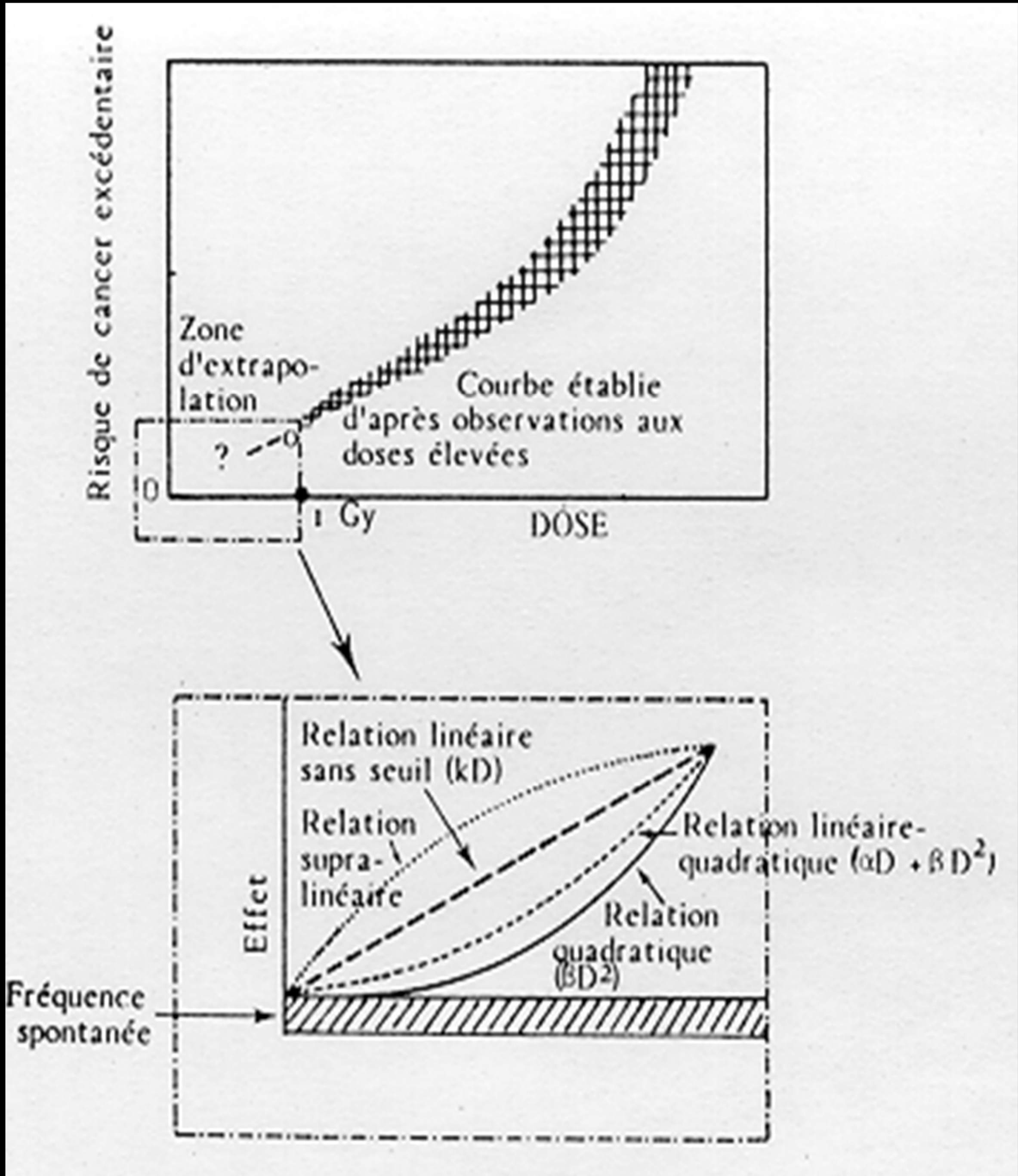
fortes doses (> 0.5 Gy)

- effets déterministes ou non-aléatoires
  - radiodermite
  - cataracte
  - …

17 ans - deux séances radio-ablation f. de Hiss

procédure interventionnelle hépatique (TIPPS)

embolisation MAV intra-cranienne



Risque de cancer excédentaire
Zone
d'extrapo-
lation
?
0
Courbe établie
d'après observations aux
doses élevées
1 Gy
DOSE
Relation linéaire
sans seuil (kD)
Relation
supra-
linéaire
Relation linéaire-
quadratique (αD + βD²)
Relation
quadratique
(βD²)
Effet
Fréquence
spontanée

faibles doses (< 0.5 Gy)

- effets non-déterministes ou aléatoires
  - induction de cancer
  - génétique

Irradiation itérative d'un individu !
Irradiation d'une population !

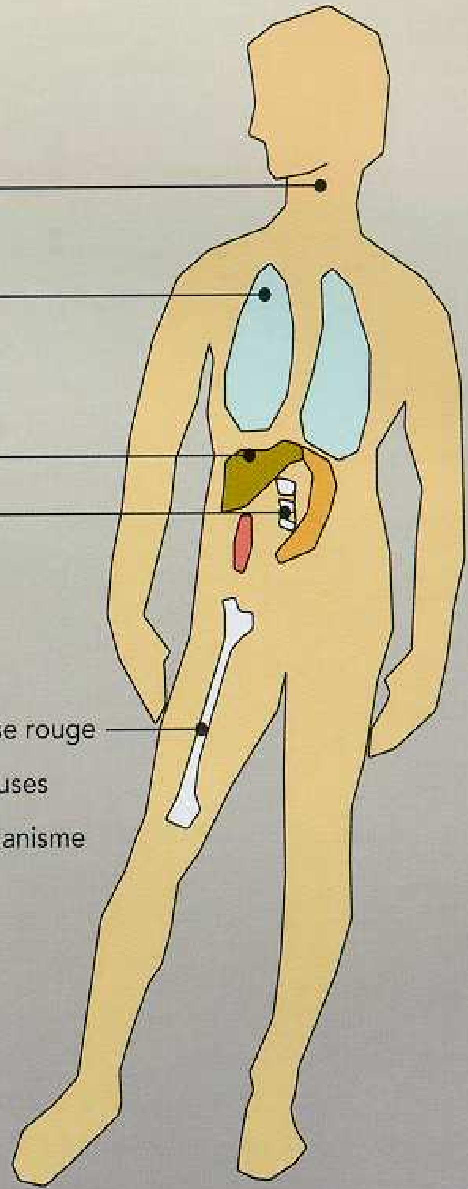
Notion de dose efficace

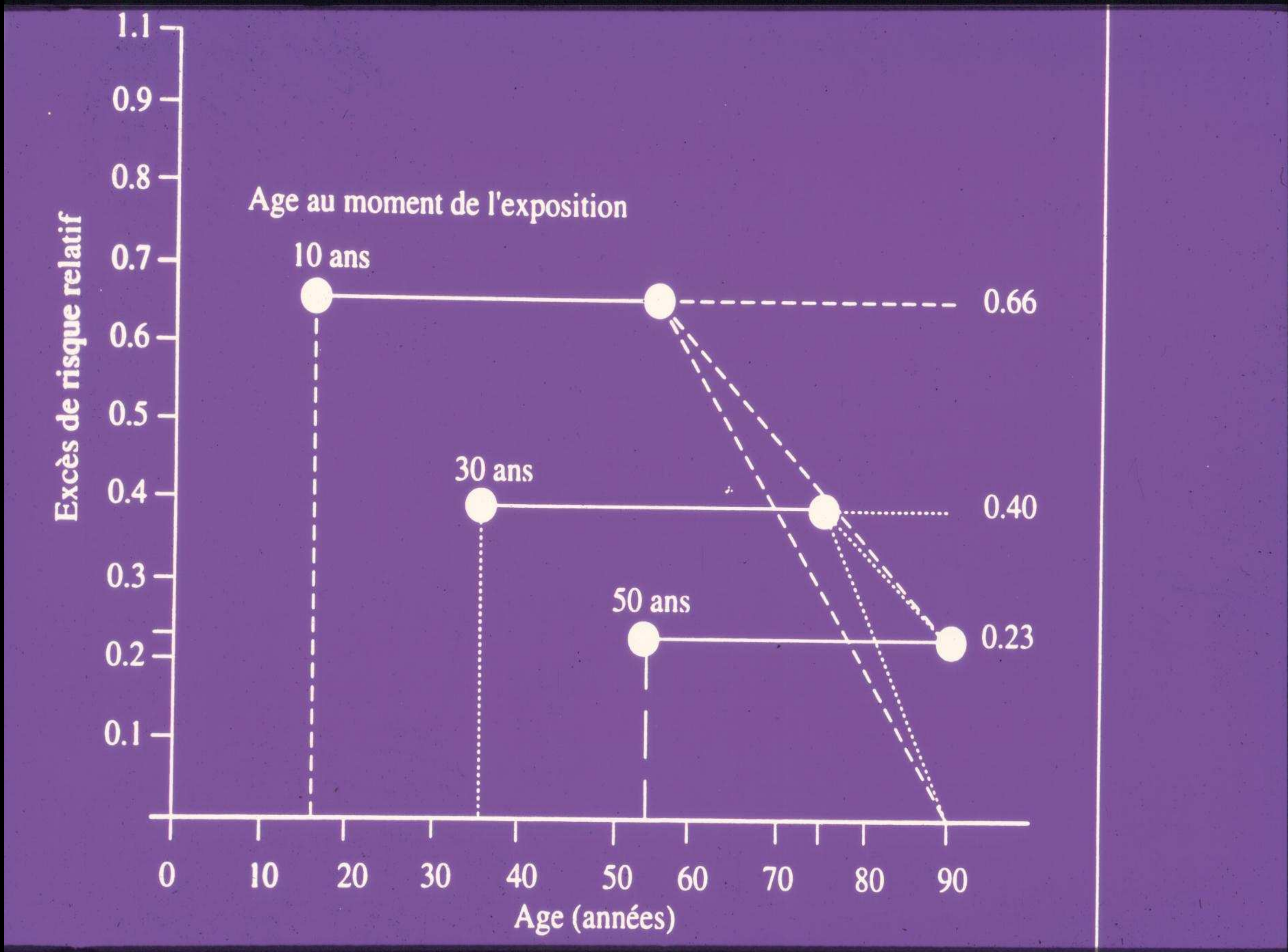
- irradiation est souvent partielle et hétérogène
- dose efficace est dose qui délivrée de manière homogène à tout le corps comporterait le même risque que la dose partielle (ou hétérogène) réellement reçue

DOSE EFFICACE - Sievert (Sv)

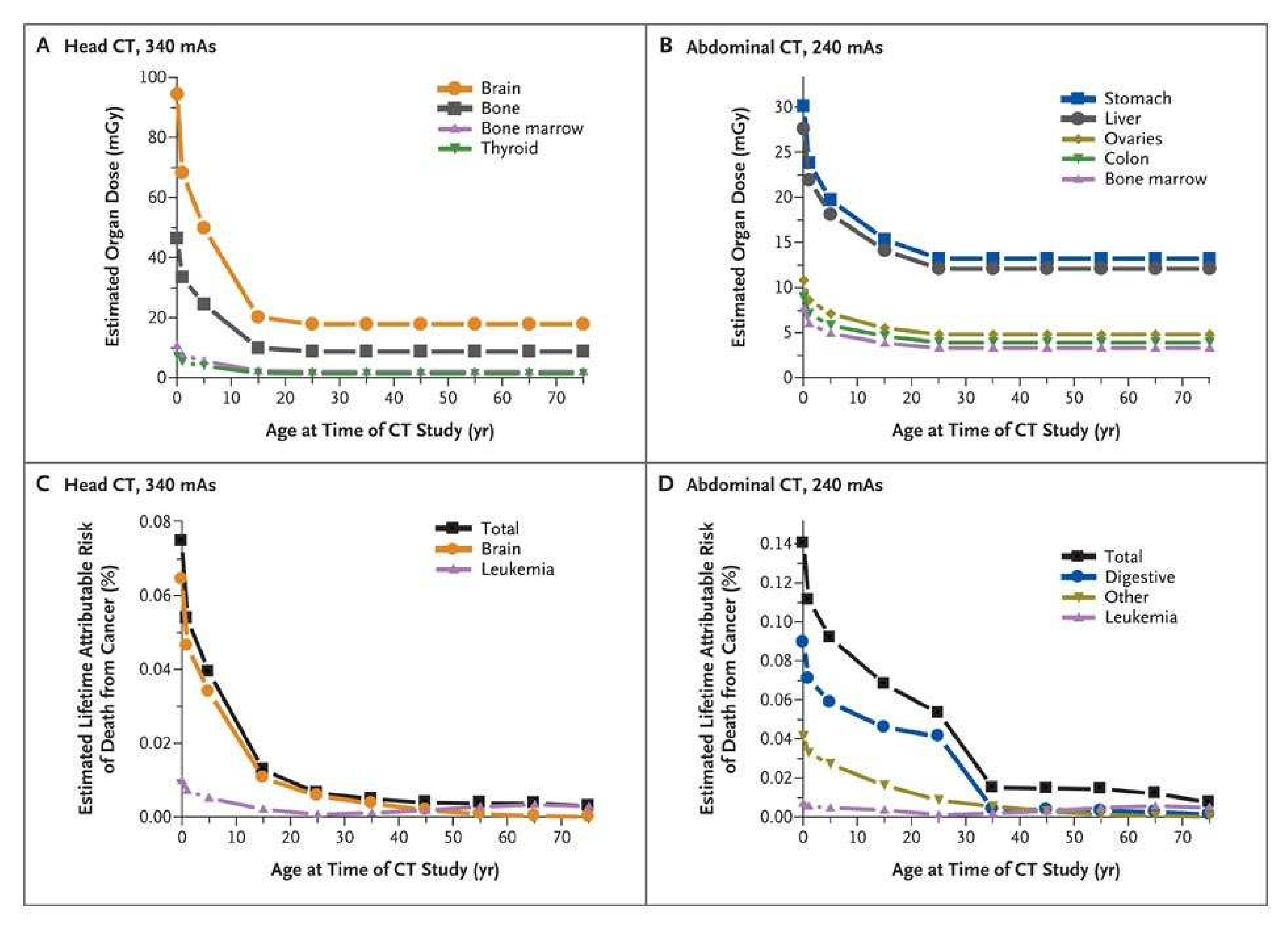
- estimation du risque ⟶ dose efficace
- introduction d'un *coefficient de risque* pour chaque organe
- W_T est facteur de pondération tissulaire
- $E = \sum_T W_T \times H_T$

0,05	Thyroïde
0,05	Sein
0,12	Poumon
0,05	Oesophage
0,12	Estomac
0,05	Foie
0,12	Côlon
0,05	Vessie
0,20	Gonades
0,01	Peau
0,12	Moelle osseuse rouge
0,01	Surfaces osseuses
0,05	Reste de l'organisme





Excès de risque relatif
1.1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
Age au moment de l'exposition
10 ans
30 ans
50 ans
0.66
0.40
0.23
0
10
20
30
40
50
60
70
80
90
Age (années)



Estimated Organ Doses and Lifetime Cancer Risks from Typical Single CT Scans of the Head and the Abdomen

The New York Times

U.S.

Search All NYTimes.com Go

WORLD | U.S. | N.Y. / REGION | BUSINESS | TECHNOLOGY | SCIENCE | HEALTH | SPORTS | OPINION | ARTS | STYLE | TRAVEL | JOBS | REAL ESTATE | AUTOS

POLITICS EDUCATION BAY AREA CHICAGO TEXAS

Radiation Worries for Children in Dentists' Chairs

An image from a cone-beam CT scanner used by dentists.

By WALT BOGDANICH and JO CRAVEN McGINTY
Published: November 22, 2010

¶ Because children and adolescents are particularly vulnerable to radiation, doctors three years ago mounted a national campaign to protect them by reducing diagnostic radiation to only those levels seen as absolutely necessary.

RECOMMEND
TWITTER
SIGN IN TO E-MAIL
PRINT

Today's Headlines Daily E-Mail

Sign up for a roundup of the day's top stories, sent every morning.

Sign Up

See Sample | Privacy Policy

MOST POPULAR

E-MAILED | BLOGGED | SEARCHED | VIEWED

1. Rabbit Ears Perk Up for Free HDTV
2. Paul Krugman: Let's Not Make a Deal
3. Doctor Faces Suits Over Cardiac Stents

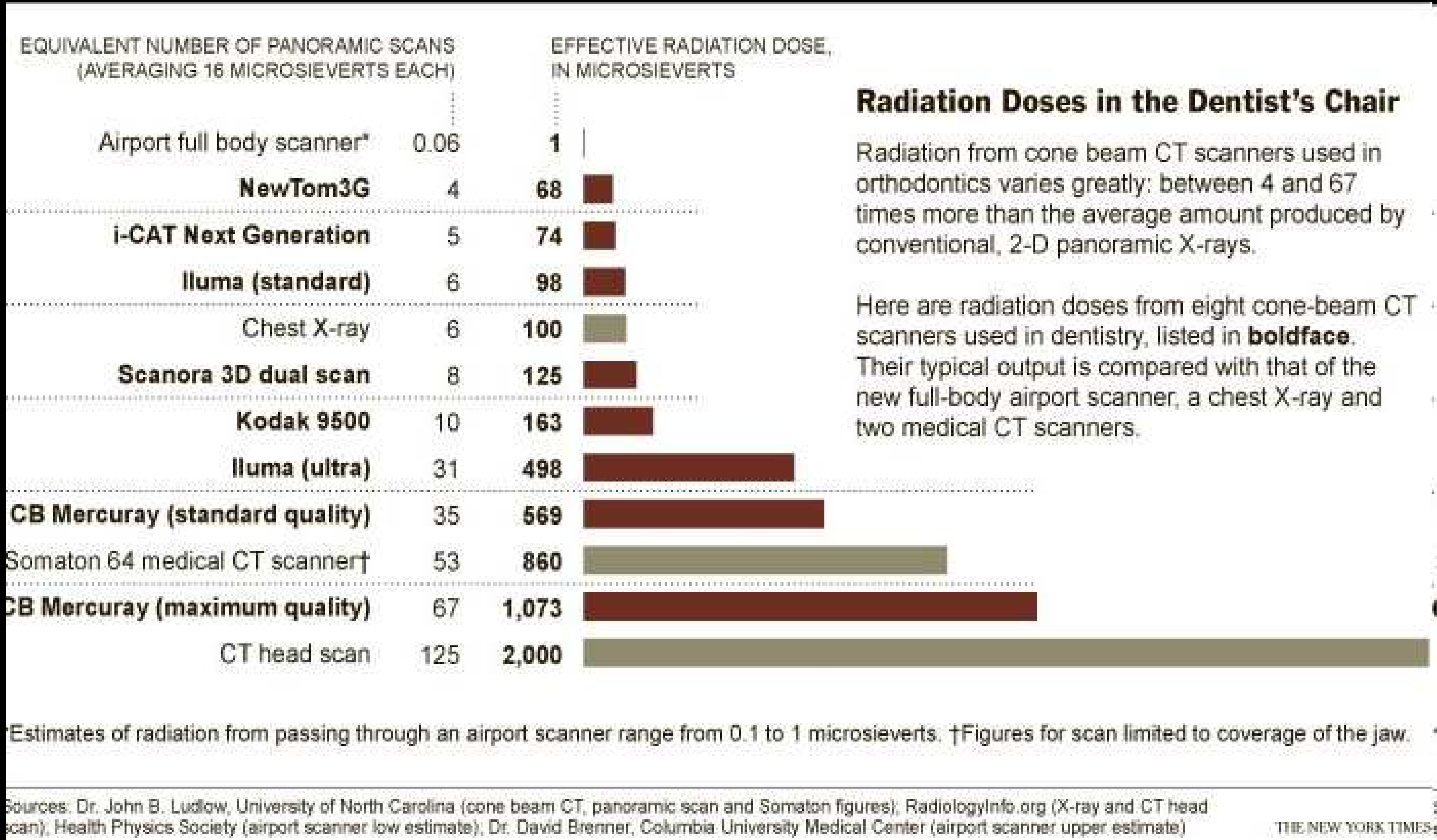

Radiation Doses in the Dentist's Chair
Radiation from cone beam CT scanners used in orthodontics varies greatly: between 4 and 67 times more than the average amount produced by conventional, 2-D panoramic X-rays.
Here are radiation doses from eight cone-beam CT scanners used in dentistry, listed in boldface. Their typical output is compared with that of the new full-body airport scanner, a chest X-ray and two medical CT scanners.
EQUIVALENT NUMBER OF PANORAMIC SCANS (AVERAGING 16 MICROSIEVERTS EACH)
EFFECTIVE RADIATION DOSE, IN MICROSIEVERTS
Airport full body scanner* 0.06 1
NewTom3G 4 68
i-CAT Next Generation 5 74
Iluma (standard) 6 98
Chest X-ray 6 100
Scanora 3D dual scan 8 125
Kodak 9500 10 163
Iluma (ultra) 31 498
CB Mercuray (standard quality) 35 569
Somaton 64 medical CT scanner† 53 860
CB Mercuray (maximum quality) 67 1,073
CT head scan 125 2,000
*Estimates of radiation from passing through an airport scanner range from 0.1 to 1 microsieverts. †Figures for scan limited to coverage of the jaw.
Sources: Dr. John B. Ludlow, University of North Carolina (cone beam CT, panoramic scan and Somaton figures); RadiologyInfo.org (X-ray and CT head scan); Health Physics Society (airport scanner low estimate); Dr. David Brenner, Columbia University Medical Center (airport scanner upper estimate)
THE NEW YORK TIMES

Table 1

Natural Radiation Exposure ~ 3 milliSeiverts (mSv) per year[6]	Estimated mSv	Comparable to natural radiation exposure for:
Daily exposure to natural radiation	0.008	~ 1 day
Flight: London to Los Angeles	0.080[7]	~ 10 days

Table 2

Dental Imaging	Estimated mSv (2007 ICRP tissue weights)	Comparable to natural radiation exposure for:
Single intraoral x-ray, film	<0.0083 mSv*[8]	~1 days
Intraoral full mouth series (film x-rays; F-speed, round cone)	0.170 mSv[9]	~22 days
2-D Panoramic (digital)	0.014 - 0.024 mSv[10]	~ 2 – 3 days
3-D Dental Cone Beam (includes multiple Fields of View)	0.003 – 1.073 mSv[11,12]	~ 8 – 134 days
3-D Cone Beam (i-CAT 0.3 voxel, 13x16 cm)[†]	0.087 mSv[13]	~ 11 days
Medical CT of skull (Somaton 64MDCT)	0.860 mSv[14]	~ 108 days

*no data available calculated subsequent to ICRP2007

Table 1

Natural Radiation Exposure ~ 3 milliSeiverts (mSv) per year[6]	Estimated mSv	Comparable to natural radiation exposure for:
Daily exposure to natural radiation	0.008	~ 1 day
Flight: London to Los Angeles	0.080[7]	~ 10 days

Table 3

Medical Imaging [15 (table)]	Estimated mSv	Comparable to natural radiation exposure for:
CT abdomen	10 mSv	3 years
CT body	10 mSv	3 years
CT colonography	10 mSv	3 years
CT lower GI	2 – 4 mSv	1 year
CT upper GI	6 – 8 mSv	2.5 years
Chest x-ray (not CT)	0.080 mSv	10 days

Qualité des images ?

Table VI. Assigned resolution values of the C phantom and the variation explained by scan settings

Image setting	*Clear separation of 4 lines (mm)*	*Pattern of 4 lines (mm)*	*Ranking by clear separation*	*Ranking by pattern*
13 cm, 40 s, 0.4 mm voxel	0.823	0.673	7	7
13 cm, 20 s, 0.4 mm voxel	0.807	0.693	6	10
13 cm, 10 s, 0.4 mm voxel	0.860	0.704	12	12
13 cm, 20 s, 0.3 mm voxel	0.848	0.697	11	11
13 cm, 40 s, 0.25 mm voxel	0.804	0.666	5	5
8 cm, 20 s, 0.4 mm voxel	0.838	0.676	9 (tie)	8
6 cm, 20 s, 0.4 mm voxel, mandibular	0.790	0.659	4	4
6 cm, 20 s, 0.4 mm voxel, maxillary	0.785	0.657	3	3
6 cm, 10 s, 0.4 mm voxel	0.832	0.668	8	6
6 cm, 10 s, 0.3 mm voxel	0.838	0.683	9 (tie)	9
6 cm, 40 s, 0.2 mm voxel, mandibular	0.622	0.398	1	1
6 cm, 40 s, 0.2 mm voxel, maxillary	0.638	0.405	2	2
R1-R2 ICC	0.782	0.914		

J.W. Ballrick A. J. of Orthodontics and Dentofacial Orthopedics (oct. 2008)

HAUTE AUTORITÉ DE SANTÉ

TOMOGRAPHIE VOLUMIQUE A FAISCEAU CONIQUE DE LA FACE (*CONE BEAM COMPUTERIZED TOMOGRAPHY*)

TEXTE COURT DURAPPORT D'EVALUATION TECHNOLOGIQUE

Décembre 2009

Indications et champs d'application cliniques

- *Cariologie* non indiqué
- *Endodontie* cas sélection.
  - bilan péri-apical pré-chirurgical
  - canal radiculaire supplémentaire
  - patho. radiculaire (fracture, résorption)/péri-apicale
- *Parodontologie* petit nombre cas sélection.
- *Implantologie et chir. buccale* *
- *Chir. maxillo-faciale* *

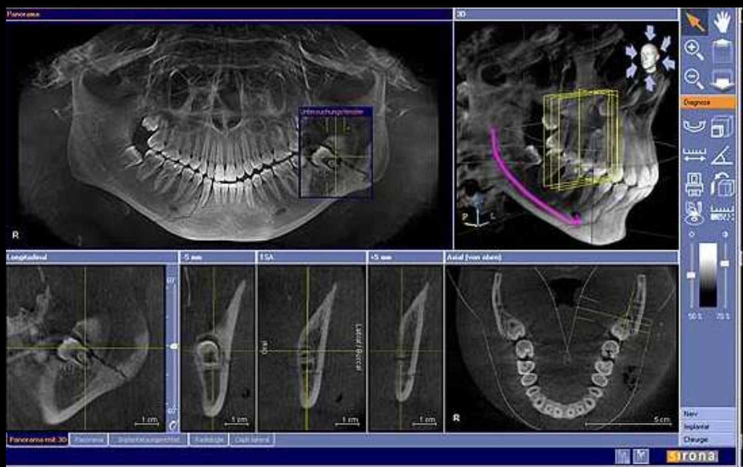
* pas d'exploration des tissus mous et irradiation inférieure à TDM

Indications et champs d'application cliniques

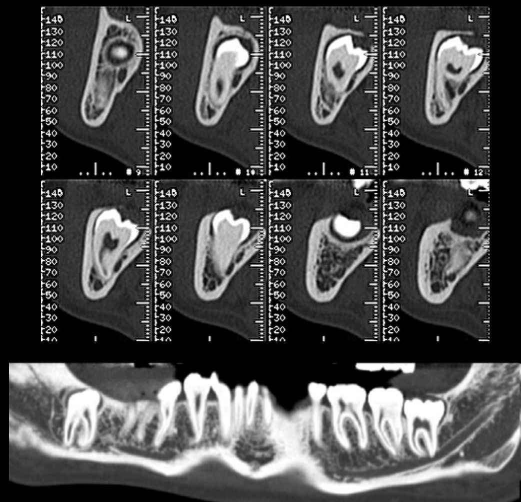
- *Orthodontie* non indiqué
  - céphalométrie par téléradiographie
  - CBCT remplace TDM si elle est indispensable
- *ORL* substitution
  - sinus
  - oreille moyenne
- *ATM* substitution
  - trauma
  - dégénératif

cliché intra-oral

orthopantomogramme



cone-beam CT



TDM hélico. (dentascan)

ALARA

"As Low As Reasonably Achievable"

1. principe de justification

2. principe d'optimisation