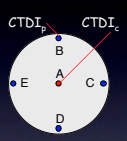
Probleme der Dosimetrie bei hochzeiligen CT-Scannern

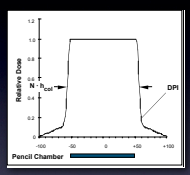
H.D. Nagel

Philips Healthcare, Hamburg
Clinical Science X-ray & CT

Grenzen der aktuellen CT-Dosimetrie



Meßorte



$$CTDI_{100} = \frac{1}{N \cdot h_{col}} \int_{-50}^{+50} D(z) \cdot dz = \frac{DPI}{BW}$$

DPI = dose profile integral (in mGy·cm)
BW = nominal beam width (in cm)

$$CTDI_{100} = \frac{DPI}{10}$$

if BW > 100 mm

?

Literatur zum Thema

A new look at CT dose measurement: Beyond CTDI
Robert L. Dixon[a)]
Department of Radiology, Wake Forest University School of Medicine, Winston-Salem, North Carolina 27157-3068

Med. Phys. 30 (2003), 1272-1280

Enlarged longitudinal dose profiles in cone-beam CT and the need for modified dosimetry
Shinichiro Mori, Masahiro Endo,[a)] Kanae Nishizawa, and Takanori Tsunoo
National Institute of Radiological Sciences, Chiba 263-8555, Japan
Takashiko Aoyama
School of Health Sciences, Nagoya University, Nagoya 461-8673, Japan
Hideaki Fujiwara and Kenya Murase
School of Allied Health Sciences, Faculty of Medicine, Osaka University, Osaka 567-0871, Japan

Med. Phys. 32 (2005), 1061-1069

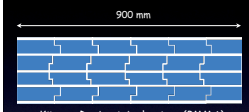
Conversion factor for CT dosimetry to assess patient dose using a 256-slice CT scanner
S MORI, PhD, MPH, RT, K NISHIZAWA, PhD, MPH, M OHNO, MSc, MPH and M ENDO, PhD, MPH

BJR 79 (2006), 888-892

The trouble with CTDI$_{100}$
John M. Boone[a)]
Department of Radiology and Biomedical Engineering, University of California Davis Medical Center, Ellison Building, 4860 Y Street, Suite 3100, Sacramento, California 95817

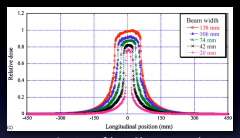
Med. Phys. 34 (2007), 1364-1371

Mori: Dosimetrie am 256-Schicht-CT

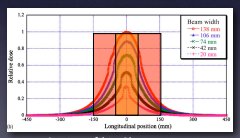


Körper-Dosimetriephantom (PMMA) mit 900 mm Länge

Si-PIN-Diode zur Ermittlung des Dosisprofils



Dosisprofil am Phantomrand



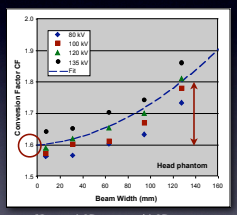
Dosisprofil im Phantomzentrum

Befund:
- Phantomlänge mind. 300 mm
- Messkammer mind. 300 mm
- damit 90%ige Erfassung des Dosisprofils

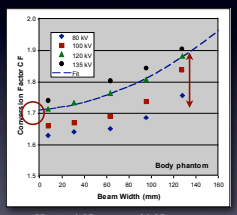
Q: Mori et al., Med. Phys. 32 (2005), 1061-1069

Mori et al.: DPI$_{300}$ vs. DPI$_{100}$

Dosimetrie
- DPI$_{100}$: 100 mm lange Meßkammer, 14 cm langes Phantom (wie bisher)
- DPI$_{300}$: 300 mm lange Meßkammer, 30 cm langes Phantom (neu)



$CF_{Head} = DPI_{w,300,Head} / DPI_{w,100,Head}$

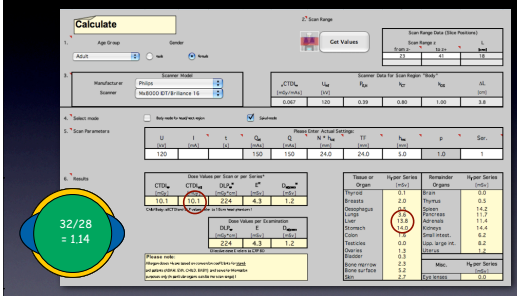


$CF_{Body} = DPI_{w,300,Body} / DPI_{w,100,Body}$

- ‚Long Range Effect (LRE)': Faktor 1.6 (Kopf) bzw. 1.7 (Rumpf)
- ‚Broad Beam Effect (BBE)': Faktor 1.1 @ 128 mm nom. Strahlbreite

Q: Mori et al., BJR 79 (2006), 888-892

CTDI vs. Organdosis

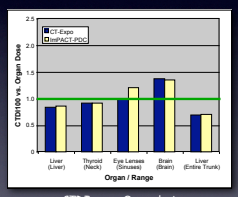


- Unterschiede u.a. bedingt durch Phantomquerschnitt < 32 cm
- CTDI$_{vol}$ gute Näherung für Organdosis ?

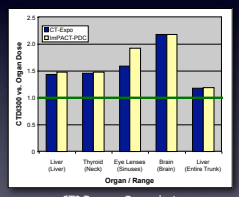
CTDI vs. Organdosis

Scanner:
- Elscint CT Twin
- GE LightSpeed 16
- Philips Brilliance 16
- Picker PQ2000
- Siemens Sensation 16
- Toshiba Aquilion 16

Bedingungen:
- 120 kV
- 10 mm Strahlbreite



$CTDI_{100}$ vs. Organdosis

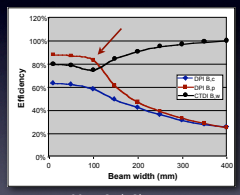


$CTDI_{300}$ vs. Organdosis

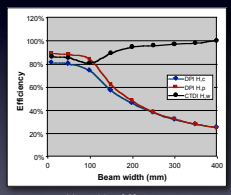
- Mit $CTDI_{300}$ signifikante Überschätzung der Organdosis
- Argument für Beibehaltung der $CTDI_{100}$-Dosimetrie.

Boone: MC-Simulation bis 400 mm BW

Dosimetrie
- $DPI_{100/inf}$: 100 mm lange Meßkammer, unendlich langes Phantom
- $DPI_{inf/inf}$: unendlich lange Meßkammer, unendlich langes Phantom
- Efficiency = $DPI_{100/inf}$ / $DPI_{inf/inf}$



32 cm Body Phantom



16 cm Head Phantom

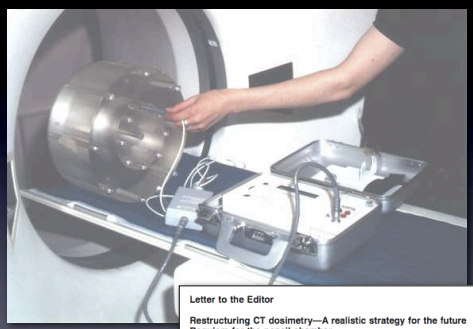
$$CTDI_{100} = \frac{DPI}{BW}$$ falls BW ≤ 100 mm

$$CTDI_{100} = \frac{DPI}{10}$$ falls BW > 100 mm

Q: Boone, Med. Phys. 34 (2007), 1364-1371

Zusammenfassung

- $CTDI_{100}$-Dosimetrie diskutabel bei mehr als 4cm Strahlbreite
  - spätestens, wenn Strahlbreite > 100 mm
- Mori et al.-Daten: erhebliche Probleme bereits bei 10 mm (?)
  - ‚Long range effect': Faktor 1.6-1.7 unabhängig von Strahlbreite
  - für begrenzte Scans und Organe nicht relevant
  - $CTDI_{100}$ gute Näherung für Organdosis
- ‚Broad beam effect' vergleichsweise klein
  - nur Faktor 1.1 bei 128 mm nomineller Strahlbreite
- $CTDI_{300}$ anstelle von $CTDI_{100}$?
  - signifikante Überschätzung der Organdosis
- Plädoyer für Beibehaltung des $CTDI_{100}$
  - einzige Modifikation: Normierung auf 10 cm, wenn Strahlbreite > 100 mm
  - Vorteil: vorhandene Messtechnik weiterhin verwendbar
  - ebenso Referenzwerte
  - ebenso Konversionsfaktoren.



Letter to the Editor

Restructuring CT dosimetry—A realistic strategy for the future Requiem for the pencil chamber

(Received 30 October 2005; revised 21 July 2006; accepted for publication 21 July 2006; published 27 September 2006)

[DOI: 10.1118/1.2336504]

Dixon, Med. Phys. 33 (2006), 3973-76

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