Radiation Protection in Dental Radiology

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Introduction

480 million dental diagnostic x-ray examinations annually

15% of all diagnostic x-ray examinations

Introduction

480 million dental diagnostic x-ray examinations annually

15% of all diagnostic x-ray examinations

Most in healthcare level 1 countries

Annual global collective effective dose 11,000 man.Sv

Introduction
Radiation protection in dental radiology: of trivial importance?

Primary care location
Lack of medical physics support
Lack of robust quality assurance programmes
No specialised radiographers/ imaging technicians
Introduction
Radiation protection in dental radiology: of trivial importance?

Paediatric use is high

<table>
<thead>
<tr>
<th>Health-care level</th>
<th>Country</th>
<th>Age distribution (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0–15 years</td>
</tr>
<tr>
<td>I</td>
<td>Bulgaria</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Czech Republic</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Japan</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Luxembourg</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>Romania</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Spain</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Switzerland</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Weighted average</td>
<td>12</td>
</tr>
<tr>
<td>III</td>
<td>Zimbabwe</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>80</td>
</tr>
<tr>
<td>IV</td>
<td>Maldives</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>15</td>
</tr>
</tbody>
</table>

**Introduction**
Radiation protection in dental radiology: of trivial importance?

Paediatric use is high

*Data from Dental Practice Board of England and Wales*
Introduction

International Conference on Radiation Protection in Medicine - Setting the Scene for the Next Decade.
Bonn, Germany, 3 - 7 December 2012
Scope of dental radiological practice

Intraoral radiography

Cephalometric radiography

Panoramic radiography
Scope of dental radiological practice

Cone Beam CT (CBCT; DVT)
## Radiation doses

<table>
<thead>
<tr>
<th>Technique</th>
<th>*Effective dose ((\mu\text{Sv}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intra-oral radiograph</td>
<td>&lt; 1.5</td>
</tr>
<tr>
<td>Cephalometric radiograph</td>
<td>&lt; 6</td>
</tr>
<tr>
<td>Panoramic radiograph</td>
<td>2.7 – 24</td>
</tr>
<tr>
<td>CBCT (dento-alveolar)</td>
<td>11-674 (median = 61)</td>
</tr>
<tr>
<td>CBCT (craniofacial)</td>
<td>30-1073 (median = 87)</td>
</tr>
<tr>
<td>Multislice CT (dental implant planning scan)</td>
<td>280-1410</td>
</tr>
</tbody>
</table>

*data from* Radiation Protection 172: Cone Beam CT for Dental and Maxillofacial Radiology. Evidence-based Guidelines, 2012
Radiation doses


International Conference on Radiation Protection in Medicine - Setting the Scene for the Next Decade. Bonn, Germany, 3 - 7 December 2012.
Justification issues

Self-referral

“mmm...I would like to take a radiograph”

“let me see.... Yes, I think that would be justified”
Justification issues

Self-referral

Fears of litigation

Factors influencing the frequency of bitewing radiography in general dental practice


Majority of dentists were influenced, or strongly influenced, in favour of taking radiographs by concerns over the medico-legal consequences of not taking radiographs.

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Justification issues

Self-referral
Fears of litigation
Patient expectations
Peer pressure
Preconceived ideas and fixed practices

Factors influencing the frequency of bitewing radiography in general dental practice


Majority of dentists were influenced, or strongly influenced, in favour of taking radiographs by the patient requesting X-rays to exclude disease.
Justification issues

Self-referral
Fears of litigation
Patient expectations
Peer pressure
Preconceived ideas and fixed practices
Financial influences

“X-ray imaging procedures have the highest profit margin of any procedure in the dental office”

*Quote from an article by distinguished dental radiologist in [www.dental-tribune.com](http://www.dental-tribune.com)*

Over three years, 2,100 panoramic films at $62 + 2,100 sets of four bitewings at approximately $38 = $210,000 in revenue.
Justification issues

Change in payments to dentists in English and Welsh public health service from pay-per-item to pay-per-head ("capitation")

Justification issues

Referral criteria

• Many guidelines
• Inconsistent national presence
• Variable level of “evidence-base”
• Little audit of awareness or compliance
Justification issues

Referral criteria

- Many guidelines
- Inconsistent national presence
- Variable level of “evidence-base”
- Little audit of awareness or compliance

“Recent literature reveals that the general compliance of these guidelines is very low, especially within dental schools in the United States and Canada. Little is known about the compliance outside of the dental school environment; however, it is expected to be low for various reasons.”

Justification issues

“Screening” with panoramic radiographs

For 56.3% of patients, the panoramic radiographs had no relevance to treatment.

Where patients were asymptomatic, this figure rose to 71%.

Caries (decay) diagnosis with bitewing intraoral radiography

Justification issues

Caries risk-based prescription

<table>
<thead>
<tr>
<th>Baseline bitewing examination</th>
<th>Interval to next bitewing examination</th>
</tr>
</thead>
<tbody>
<tr>
<td>At age:</td>
<td></td>
</tr>
<tr>
<td>5 years</td>
<td>Low risk 3 years</td>
</tr>
<tr>
<td>8 or 9 years</td>
<td>High risk 1 year</td>
</tr>
<tr>
<td>12 to 16 years</td>
<td>Low risk 2 years</td>
</tr>
<tr>
<td>16 years</td>
<td>High risk 1 year</td>
</tr>
</tbody>
</table>

*Table 3 - The baseline examinations and intervals to the next bitewing examination in children.*

Justification issues

Caries (decay) diagnosis with bitewing intraoral radiography

“A significant proportion of dentists in Greater Glasgow are not complying with recent guidelines and recommendations and it would appear that the value of bitewing radiography as a diagnostic tool in children is not being fully exploited.”

An investigation into the use of bitewing radiography in children in Greater Glasgow

G. K. Taylor and L. M. D. Macpherson

Justification issues

Cone beam CT

Dental practice-based alternative to referral to hospitals for CT in implant dentistry
Justification issues

Cone beam CT

Dental practice-based alternative to referral to hospitals for CT in implant dentistry

Increasing use for all aspects of dentistry
Justification issues

Cone beam CT in orthodontic practice

“......much of the literature on using large volume CBCT for routine orthodontic diagnosis and treatment was anecdotal, case report and opinion-based, with a lack of evidence of significant clinical impact”

Radiation Protection 172: Cone Beam CT for Dental and Maxillofacial Radiology (2012).

• Very limited evidence for diagnostic efficacy
• No randomised controlled trials focused on clinical outcomes
Optimization issues

Fall in collective effective doses attributable to dental radiology

Fast films and film/screen combinations

Other factors....

Optimization issues

Change in operating potential (intraoral radiography)

Improved collimation
Optimization issues

Panoramic radiography

Field size limitation
Optimization issues

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Although the average age of the equipment assessed is less than 10 y, systems more than 30 y of age are still in clinical use.

Although in a minority, pointed cones and mechanical exposure timers appear to be still in clinical use.

D and E speed X-ray film are preferentially used as opposed to the faster F speed film.

Optimization issues

Slow adoption of change

Financial cost/ other priorities

Inertia

Lack of understanding
Optimization issues

Slow adoption of change

Financial cost/ other priorities

Inertia

Lack of understanding

7. Set tube current.
   (1) Press the Tube Current key.
   (2) Up and Down keys will appear; press them to set current (1 to 10 mA).
   (3) Press the Tube Current key again.

* Recommended: 90 kV and 4 to 6 mA.
Optimization issues

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Optimization issues
Optimization issues

“Tianje” hand-held unit
Priced at £205 (€250) on eBay

UK Health Protection Agency alert (June 2012)

Little or no shielding; low kVp; short focus-patient distance

Excessive DAP value for patients (x10)

For operators, up to 40 Sv (equivalent dose) to the hands and 30 mSv (effective dose) to the body
Optimization issues

Poor quality images
Optimization issues

Dose audits and reference doses/ DRLs

**Figure 2.** Frequency plot of doses for intraoral radiography, excluding five cases with mean doses above 10 mGy.


**Figure 3.** Distribution of patient entrance doses for intra oral radiographs in the 1999 study.

Optimization issues

Dose audits and reference doses/ DRLs

Evidence for promoting optimization of exposures in dental radiology?

Optimization issues

Reference levels


Third quartile dose = 3.9 mGy

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Figure 3: Distribution of patient entrance doses for intra oral radiographs in the 1999 study.
Optimization issues

Reference levels


Third quartile dose = 2.3 mGy
Discussion

The impact of dental radiology on radiation protection of patients may be perceived as minor in view of the generally low individual and collective doses.

Several unusual factors which counter this perception:
- high number of examinations,
- frequent paediatric use,
- predominantly primary care location,
- limited interaction with medical physics support,
- self-referral,
- long working lifespan of dental x-ray equipment,
- inertia to change and lack of understanding among dentists,
- financial and other non-clinical influences,
- the developing challenges of Cone Beam CT
Radiation Protection in Dental Radiology: priorities for the next decade

Education
- Lifelong learning

Guidelines
- Audits of awareness and compliance

Research
- Optimization of exposures in CBCT. Clinical impact

Dose audit
- DRLs and constructive feedback
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