Assessment of Entrance Skin Dose of Four Groups of Children Arising from Angiography Procedures

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A Very Efficient X-ray Modality

For Quick & Accurate Diagnosis and Treatment of Children Heart Disease (CHD).

Patients receive a relatively high dose from CA & PTCA procedures. To avoid unnecessary dose (health risk) to patients,

An Accurate Knowledge of the Dose is Essential
Patient dosimetry in general:

**Direct**

- Thermoluminescent Dosimetry (TLD-100)
- Gafchromic Film

**Indirect**

0.5 Gy, 1 Gy, 2 Gy, 3 Gy, 4 Gy, 5 Gy, 6.5 Gy, 8 Gy, 10 Gy, 12.5 Gy, 15 Gy, 17.49 Gy, 19.99 Gy, 25 Gy, 30 Gy, 35.01 Gy
Dose Area Product (DAP)

- **DAP** is integral of surface absorbed dose in air.
- **DAP** Unit Gy.m$^2$ & µGy.cm$^2$
- **DAP** is almost independent of measuring distance.
- **DAP** does not include scattered radiation from the patient or phantom.
Dose Area Product (DAP)

DAP \approx D_a \cdot A.
Advantages & Disadvantages of Direct Dosimetry

- Real dose is obtained
- Relatively easy and low cost
- Not practical for individual patients in every day life.
Direct measurement of individual patient’s dose is not practical.

Aim of this study
Assessment of individual patient’s (children) dose from CA & PTCA procedures.
To estimate patients’ doses in CA & PTCA Procedures, DAP values & conversion coefficient of DAP to Dose are required.

**Estimated Patient Dose** = DAP value \( \times \) Conversion Coefficient
Equipment used to determine conversion coefficient

PMMA phantoms of four age groups

TLD (TLD-100)

Siemens AXIOM Artis Zee

According to the report IAEA (HHS No.24)

<table>
<thead>
<tr>
<th>Age</th>
<th>Height (cm)</th>
<th>Weight (kg)</th>
<th>Equivalent cylindrical diameter (cm)</th>
<th>Trunk thickness (cm) anteroposterior × lateral</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 years</td>
<td>51</td>
<td>3.5</td>
<td>9.3</td>
<td>9 × 10.5</td>
</tr>
<tr>
<td>1 year</td>
<td>75</td>
<td>10</td>
<td>13.0</td>
<td>12 × 14</td>
</tr>
<tr>
<td>5 years</td>
<td>110</td>
<td>19</td>
<td>14.8</td>
<td>14 × 17</td>
</tr>
<tr>
<td>10 years</td>
<td>140</td>
<td>32</td>
<td>17.1</td>
<td>17 × 20</td>
</tr>
<tr>
<td>15 years</td>
<td>168.1</td>
<td>56.3</td>
<td>20.7</td>
<td>19.6 × 29.66</td>
</tr>
</tbody>
</table>
How to determine conversion coefficient (29 cinegraphy views)?

1- Design of cinegraphy views (29 View + Fluoroscopy):
   • Text book of Congenital heart disease (Moss & Adams)
   • Most frequently used views by the physician in the Cathlab
2- Three TLDs were placed on phantom surface (representing 4 age groups) for each view & maximum dose was obtained→ (Dose)_i
3- DAP value of each specified view was recorded→ (DAP)_i
4- DAP to dose conversion coefficient of each specific view was determined → X_i

\[ X_i = \frac{(\text{Dose})_i}{(\text{DAP})_i} \]
**Estimation of Patient Dose**

**How?**

\[
\text{Estimated Patient dose }_{\text{view}} = \text{DAP value }_{\text{view}} \times \text{Conversion Coefficient}(X_{\text{view}})
\]

**Exam Protocol**

For each view, calculate the dose per unit DAP and sum the total estimated patient dose. The formula for the estimated patient dose per view is:

\[
X_i = \frac{(\text{Dose})_i}{(\text{DAP})_i}
\]

Where :

- \(X_{\text{Phantom}}\) is the conversion coefficient.

Total estimated patient dose is the sum of the estimated patient dose for each view:

\[
\text{Es Patient dose }_{\text{Total}} = \sum_{i=1}^{n} ((X_i) \times (\text{DAP}_i))
\]

For example:

- For view 12:
  \[
  \text{Es Patient dose }_{12} = X_{12} \times \text{DAP}_{12}
  \]

- For total:
  \[
  \text{Es Patient dose }_{\text{Total}} = \sum_{i=1}^{n} ((X_i) \times (\text{DAP}_i))
  \]
In order to validate estimated dose & conversion coefficients obtained in the study, direct dosimetry by TLDs were taken on the same patients.
Skin dose was measured for 66 patients of four age groups:

- 1 year (21 patients)
- 5-year (18 patients)
- 10-year (17 patients)
- 15-year (10 patients)

TLD -100 → 10 TLD Chips

- 10 TLD chips were placed on the individual patients’ skin surface
- 10 exposed TLDs were read by a manual 3500 Harshaw reader
Results

- Estimated dose-$D_{ES}$ (main objective of this study) for all patients were plotted versus their Measured dose- $D_M$.

- Correlation coefficients between $D_{ES}$ and $D_M$ of 1, 5, 10 and 15 year age groups were calculated and were strong for 5, 10 and 15 years age groups and was weak for one year age group.
The correlation between $D_M$ and $D_{ES}$ for all age groups
● Height, weight and total exposure time of CA or PTCA Procedures do affect patients dose in general, particularly for infants and younger patients.

● If these factors were considered for 1 year age group too, then correlation coefficients between $D_{ES}$ and $D_M$ would improve.
Height, weight and total exposure time of CA or PTCA

1 year  $R^2=0.67$

5 year  $R^2=0.88$

10 year  $R^2=0.80$

15 year  $R^2=0.83$
The results of this study are evident that the data extracted from the individual patients’ exam protocol of the system could be used to estimate individual patients’ dose following to every CA or PTCA procedures by a high degree of certainty.
REFERENCES


