ESR EUROSAFE IMAGING

Paediatric CT Practice - How safe is imaging in different countries?

CT angiography in children with congenital cardiovascular malformations - dose reduction

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1. List of the facility's CTDI and DLP for children from different age groups

Table 1: Polish Mother's Memorial Hospital- Research Institute, paediatric CTA protocols, own data from 05.2013 to 10.2013

Group	Age		scan type	current [mAs]	tube [kV]	CTDI [mGy]	DLP [mGy*cm]		EF [mSv]	
	mean	range					mean	range	mean	range
> 8 kg	55,5 d.o.	1 d.o.-14 m.o.	helical	50	80	1	40,61	34,8-54,9	1,68	1,15-2,6
			axial	50	80	1	29,7	29,7	1,15	1,15
8-20 kg	3,3 y.o.	14 m.o.-7 y.o.	helical	60	80	1,17	52,27	29,8-64,4	1,2	0,7-1,7
			axial	50	80	1	27,1	27,1	0,7	0,7
20-30 kg	8 y.o.	3-12 y.o.	helical	70	80	1,4	67,5	50,8-77,2	1,05	0,89-1,39
30-40 kg	11,5 y.o.	11-12 y.o.	helical	80	80	1,6	75,05	75,9-74,2	0,97	0,96-0,99
40-50 kg	13,5 y.o.	12-15 y.o.	helical	80	100	3,2	93,95	83,2-104,7	1,27	1,08-1,46
50-60 kg	16 y.o.	16 y.o.	helical	100	100	4,1	96,35	95-97,7	1,83	1,36-2,3
> 60 kg	17,6 y.o.	17-18 y.o.	helical	120	100	4,9	133,26	128,5-142,7	1,72	1,3-199

2. How radiation protection during paediatric CT is practised in the facility

Reduction of the dose of ionising radiation, to which patients are exposed during the CTA exams is executed by:

- Limited length of the scan, depending on the clinical question.
- Choice of scanning parameters (kV, mAs), depending on the size of the patient.
- Using the test bolus method, which enables precise determination of the best time of acquisition after contrast agent injection. This eliminates the risk of mistakes and the need to repeat exam.
- Using iterative reconstruction (iDose4) for processing images.
- Using the axial scans method in selected cases (step and shoot).
- Increasing frequency of single-phase exams with contrast agent, eliminating part of the multiphase study.

Each study in our department is performed by a radiographer following consultation with a radiologist.

3. Data on the percentage of dose reduction in CT of children

In our department we have modified protocol parameters set by the equipment producer. This has led to a decrease in radiation dose of about 45%- 75% in different age groups (Fig. 5). (Published at the 40th Polish Congress of Radiology, Wrocław 2013).

Table 2: Comparsion of mean DLP in CTA studies performed in 2011-2012 and 2013 after modifying protocols in different age groups

Age	DLP [mGy*cm]						DLP reduction
	2011-2012			2013			
	range	mean	SD	range	mean	SD	
0-3 m.o*	57,1- 186,7	93,95	39,37	29,7- 47,4	38,55	4,72	-59%
4 m.o- 2 y 11 m.o*	66,9- 168,5	117,26	37,2	27,1- 67	49,34	14,16	-58%
3 y.o- 7 y 11 m.o*	66- 200,4	107,54	44,55	50,8- 67	58,31	5,81	-46%
8 y.o- 14 y 11 m.o*	92,6- 479,8	282,63	106,22	51,4- 77,2	70,73	8,06	-75%
15 y.o and older**	112,5- 411	259,8	94,97	95- 142,7	119,09	16,95	-54%

* all data normalized to CTDIvol measured in the 16-cm diameter CT dosimetry phantom

** all data normalized to CTDIvol measured in the 32-cm diameter CT dosimetry phantom

4. How we child size our CT imaging

The choice of scanning parameter is based on the body weight of patients. We divided patients into groups: <8 kg, 8,1-20 kg, 20,1-30 kg, 30,1-40 kg, 40,1-50 kg, 50,1-60kg, >60,1 kg. Furthermore, depending on scan length, different exams methods are used (helical scan, axial scan). If the scan length does not exceed the width of the detector (80mm), we use the axial scan method (Fig 2).

5. Number of paediatric CT referrals that are reviewed by radiologists before giving appointments

Since September 2011, the new scanner (Philips Healthcare, Brilliance iCT 256) is used, and since then we perform CTA exams. From the beginning we have cooperated closely with the department of cardiology and together we determine which type of imaging study (CTA, CMR) is best for the patient (PCI studies are performed by cardiologists, and they are responsible for the patients qualification for these procedures). Thanks to this practice, we eliminated the risk of unnecessary exams. A small group of patients is initially disqualified from the CTA study, because of poor preparation for the examination (faulty intravenous, anxious patient, requiring anesthesia). After preparation of the patient, the study is carried out at a later date.

Figure 1: Male age 27 d.o., weight 1400 g, double aortic arch. 3D reconstruction. DLP 37,3 mGy*cm, EF 1,5 mSv (estimated by using effective dose, age-specific conversion coefficients for data normalized to CTDIvol measured in the 16-cm diameter CT dosimetry phantom for patients younger than 15 years and for 32-cm diameter phantom for older patients).

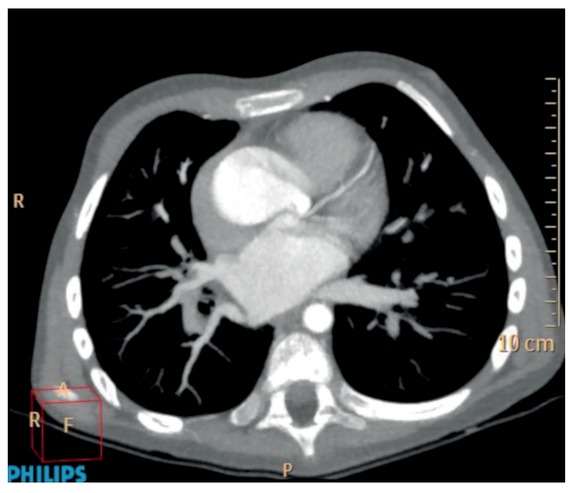

Figure 2: Male age 11 m.o. weight 8,5 kg, axial scan method. Short scan time (rotation time 0.27 s, 0.18 s scan time) allows for high quality images of the heart without motion artefacts, despite the absence of ECG gating. This helps evaluate small structures such as the coronary arteries.

Figure 3: Female age 12 y.o., weight 26 kg, arteria lusoria, DLP 69,8 mGy*cm, EF 0,9 mSv.

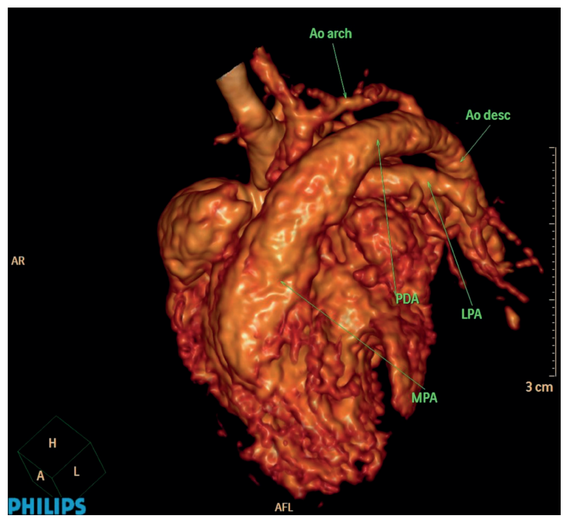

Figure 4: Male age 5 d.o., weight 1200 g, hipoplastic aortic arch, PDA, DLP 37 mGy*cm, EF 1,4 mSv.

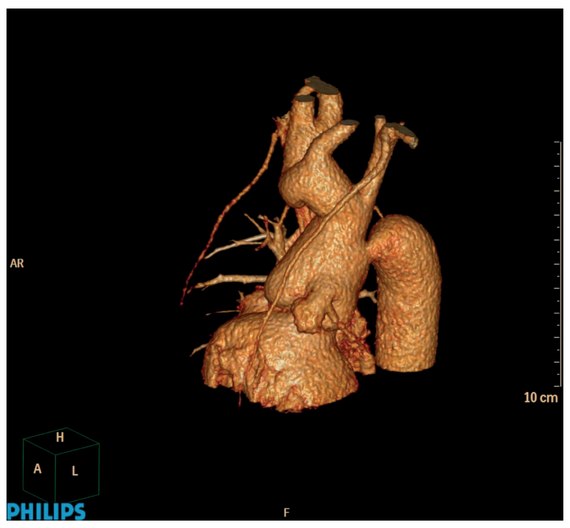

Figure 5: Female age 3 y.o, weight 15 kg, aortic coarctation DLP 50,8 mGy*cm, EF 0,91 mSv.

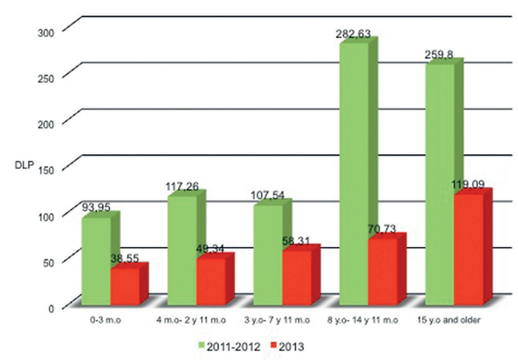

Figure 6: Plot showing the decrease mean DLP different age groups between the first studies (2011-2012) made in our department and the last (2013).