P3-033

OUT-OF-FIELD DOSE MEASUREMENT IN PHOTON AND PROTON CRANIOSPINAL IRRADIATION OF PAEDIATRIC PATIENTS – EURADOS WG9 PHANTOM STUDY

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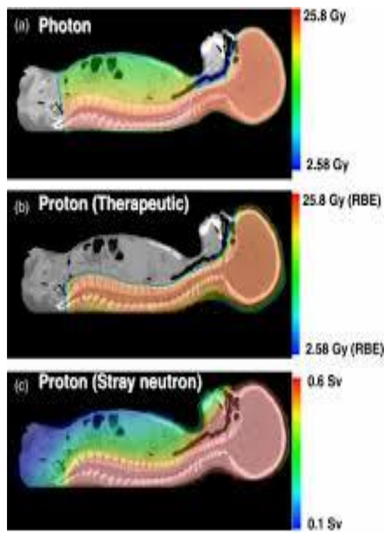
EURADOS European Radiation Dosimetry Group — EURADOS Working Group 9 (Radiation Dosimetry in Radiotherapy)

1. Introduction – importance of out-of-field measurement!

- Out-of-field doses, caused by stray radiation, may increaase sencondary cancer risk for radiotherapy (RT) patients
- Children are of particular concern due to higher radiosensitivity and longer life expectancy in comparison to adults. There is still lack of paediatric out-of-field RT data[1]. Experimental data are needed to test analytical models that are developing
- Craniospinal (CS) irradiation increased tremendously survival rate for the patients with medulloblastoma which is the most common malignant brain tumour in children
- This study evaluates and compares out-of-field doses for paediatric medulloblastoma treatment using photon and proton CS irradiation



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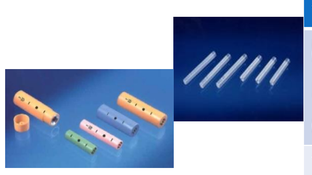
2. Materials and Methods

Dosimetry systems[3]:

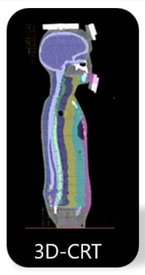


Dosimetry system	Type	Material	Sensitive to	Participant	Radiotherapy technique, phantom
Radiophoto-luminescent (RPL)	GD-352M	Ag activated phosphate glass	Photons	RBI	3D-CRT, 5y PBS, 10y
Thermo-luminescent (TL)	MCP-n	^{nat}LiF:Mg, Cu, P	Photons	SCK-CEN	3D-CRT, 5y
	MTS-7	^{7}LiF:Mg, Ti	Photons	IFJ, NPI	3D-CRT, 10y
	MTS-6	^{6}LiF:Mg, Ti	Photons + thermal neutrons	NPI	3D-CRT, 10y
Nuclear track detector	PADC	Polly-allyl-diglycol-carbonate (PADC)	Neutrons	NPI	PBS, 10y

Paediatric anthropomorphic CIRS phantoms – slices are made of tissue equivalent materials with holes for dosimeters

Irradiation techniques:

Photon therapy:
Irradiations at UHT Zagreb
Siemens Artiste LINAC
3D Conformal radiotherapy (3D-CRT)
Dosimeters in all out-of-field organs



Target volume same for all irradiations: whole brain and spinal cord + 0.5 cm margin

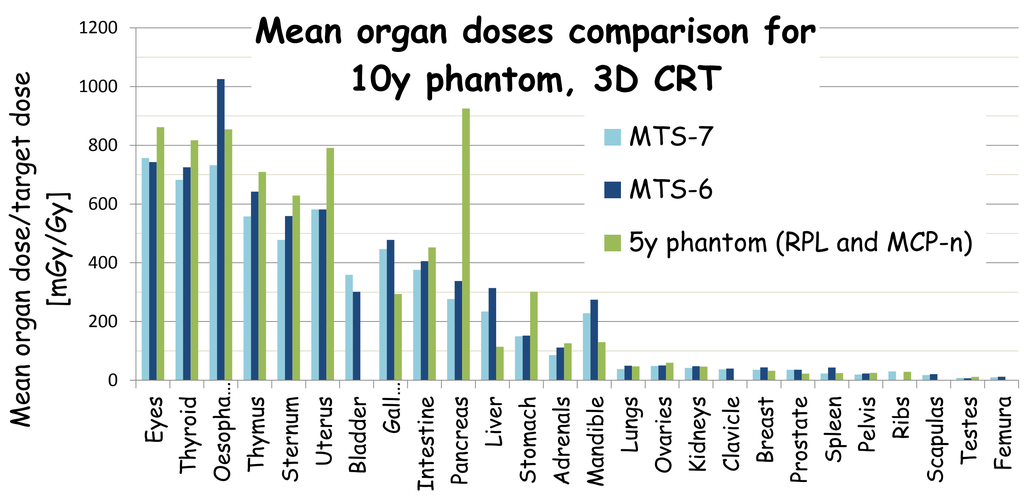
Plan
- Brain with LL field, field in field 6MV
- Spinal cord with AP field in field, 6MV,18MV
- Two plans with different junction point (difference of 1cm)
- Mean target dose 1.8 Gy

Proton therapy (PT):
Irradiations at CCB Krakow
Proteus C-235 (IBA)
Pencil beam scanning (PBS) technique
Dosimeters only in the selected radiosensitive organs close to spinal cord
Target dose 100 Gy

3. Results

For photon 3D-CRT CS radiotherapy:

- Comparison of different luminescent dosimetry systems for 3D CRT:
  avearage RPL / MCP-n = 1.02 ± 0.15 -> good agreement
- Presence of neutrons due to use of 18 MV photon beams ⇒ doses measured with MTS-6 are higher than doses measured with MTS-7
  (the highest gamma equivalent neutron dose in 10y phantom was 293 mGy/Gy for oesophagus)



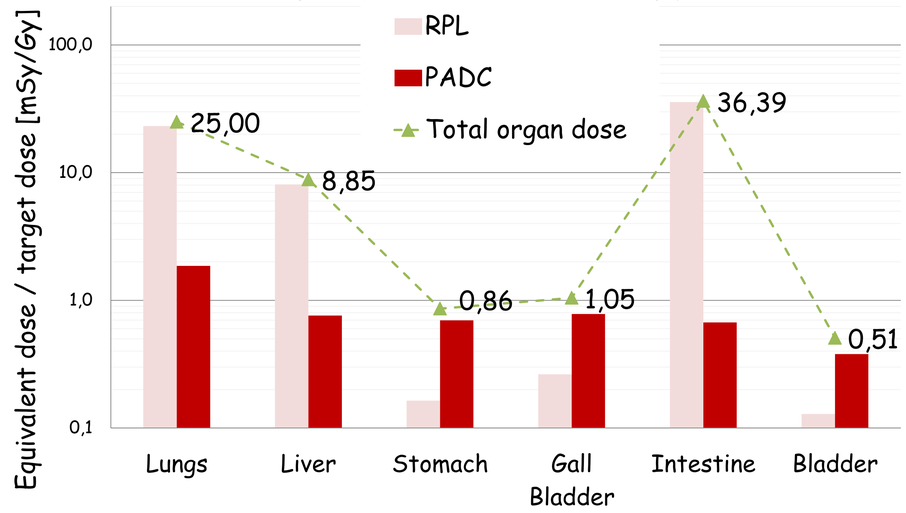
- Organ doses: > 50% isodose for central axis organs (and 5y > 10y due to closer proximity of 5y-organs to the spine)
  < 10% isodose for lateral organs

For proton CS radiotherapy using PBS:

For selected out-of-field organs:

- Non-neutron doses (RPL) are higher organs closer to the spine, while neutron doses (PADC) are higher in organs further away from the spine.

Mean equivalent organ doses for 10y phantom, proton CS radiotherapy



Note:
PADC were overirradiated (dose equivlent per target dose was estimated > 2 mSv/Gy) for:
- all points in oesophagus, thyroid, gall blader, breasts and prostate
- some points in interstine, blader, liver, lungs

- Comparison of same points in 10y phantom, treated with photons using 3D-CRT and protons, showed that stray radiation doses are 1- 3 orders of magnitude lower for proton radiotherapy.

4. Conclusions

For selected organs in paediatric phantom, CS treatment with protons showed significantly lower out-of-field doses in comparison to photon radiotherapy using 3D-CRT

References: 1. Majer et al. 2017 Radiat. Prot. Dos . 176 331 2. Zhang et al. 2013 Phys. Med .Biol. 58 807
3. R. Harrison et al. 2017 EURADOS Report 2017-01. 4. De Saint-Hubert et al., 2017 Phys. Med. Biol. 62 5293