Two Dimensional (2D) vs Three dimensional (3D) treatment planning in Paediatric Radiation Oncology. Less technology can be acceptable?

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Introduction

- Low Income Countries (LIC) has restriction to technology causing delay in Radiotherapy (RT). It could be educative evaluate when 2D plannings could be used safely. During a project supported by IAEA –PRON- Optimization of radiotherapy in low resource settings: pediatric cancer patients” – that we had enrolled patients (pt), we compared 2D and 3D plannings in some pt that agreed to participate and/or performed also 2D planning for any reason.

- **PURPOSE:** The goal was compare in the same patient the two different modalities 2D vs 3D to detect in which situations would be acceptable to perform a 2D planning.

- **METHODS:** All patients were planned at a digital simulator using planar RX (2D). The physician defined fields and protections based on bone marks and/or Computed Tomography (CT), magnetic resonance image (MRI) to evaluate the target, margins and OAR. All the 2D plannings were performed first. After the procedure at the simulator, all the patients were also submitted to CT planning and all the structures (GTV, CTV, PTV and OAR) were contoured by the same physician in TPS. The patients were then planned to 3D treatment. They were planned using a TPS Eclipse Varian to calculate the 2D and 3D plannings. The fields and MLCS defined by the physician at the Simulator were copied to the CT of the patients and the 2D planning reconstructed and calculated in TPS. The comparison of the 2 plannings (2D vs 3D) were performed at the TPS and the doses to the targets and OARs analyzed using dose volume histogram data. Statistic analysis were done using Wilcoxon Non parametric Test. BioEstat 5.0 software - p ≤ 0.05.
Results I

- **RESULTS:** We studied 28 patients, 15 male, 13 female, (18 months to 21 years old), mean age 8.5 years. We had different cases and sites: Cranio-Spine Irradiation (CSI) (4); leukemia (Brain to C2-3 irradiation) (3); lymphoma (2); wilm’s tumor (5); whole abdominal irradiation (WAI + boost) (3), WLI (2); combined sites (1); **Soft tissue tumors (STT)** (6): of face (2) of extremities (2) of thorax (2), of combined sites (2); Central Nervous System (CNS) tumors (8). We observed:

- **CSI and leukemia cases**
  - Dose to thecal sac was efficient in 4/4 pts.
  - Dose to PTV, CTV – no differences; p = 0.25
  - Cribriform plate coverage lower than 95% vol in 2/7 pt (28.5%)
  - 2D vs 3D planning - Wilcoxon – no significant difference; p = 0.069

- **Lymphoma cases**
  - 2 cases of thorax involved field irradiation
  - The cover of GTV, CTV and PTV were very similar but the doses to lungs were increased
  - V20 – increased 50%, V15 – increased 30%, V5 - increased 15% and mean dose increased 44%

- **Soft tissue tumors cases (STT)**
  - **STT face (4)** Dose to GTV was unsatisfactory (20% less) and unacceptable to CTV and PTV 30 to 40% lower than 3D
  - PTV and CTV coverage were significantly lower than 3D plannings; p = 0.03 Figure 1.
  - Mean dose to PTV and CTV were also statistically significant lower in 2D than 3D, p = 0.03.

- **STT others cases**
  - **Thorax – (2)** The doses PTV, CTV were (30%) lower in 2D than 3D. Dose to lungs were increased
  - **Extremities + face or thorax (2)** The doses to PTV and CTV were similar

**Figure 1.** Graph showing comparison between PTV Coverage 2D vs 3D p = 0.03 STT face cases
Results II

- **Wilm’s tumor cases**
  - We did not observe difference in PTV and CTV coverage between 2D vs 3D to WAI and boost doses.
  - Dose to kidney, femur and gonads were higher with 2D but were not significant – p = 0.054.
  - Plannings of WLI were similar to coverage CTV and PTV.

- **CNS tumors cases**
  - The GTV coverage was lower in 2D plannings but not significant – p = 0.064.
  - The PTV coverage (p= 0.021) Figure 2 and PTV Mean dose (0.037) were statistically significant lower in 2D plans.
  - The same to coverage to CTV (p=0.04) and mean dose (p=0.045).

*Figure 2.* Graph showing comparison of PTV coverage between 2D vs 3D p= 0.021 CNS cases.
Discussion/conclusions

**Discussion:** Some paediatric diseases like Wilm’s tumor, STT, CSI and leukemia cases can be treated with low complexity. 2D plannings could be good options of radiation techniques in that situations specially in Low Income countries where the accessibility to hight technology is limited. Tumors in Brain, head and neck region and thorax have higher benefits with 3D plannings because the critical relation of the tumor with the OARs and the possibility of better protection with conformal treatments.

**Conclusions:** Based in this cases, 2D plannings of WLI, WAI in Wilm’s tumor and STT of extemities are safe and acceptable, CSI and leukemia 2D plannings can be done relatively safe but with care to cribriform plate coverture. Plannings of STT face, STT thorax and lymphomas were unacceptable. The worst situation was the CNS tumors to perform 2D plannings.