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Abstract Title: Dosimetric Impact of Iodine-, Barium- and Gadolinium-Based Contrast Agents in Proton Therapy Planning

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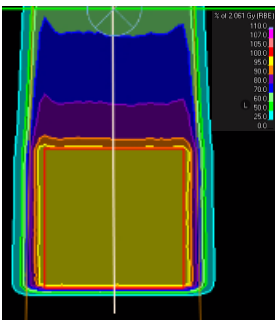
Background / Aims:

- The use of contrast agents can introduce density changes that affect proton range and dose deposition. When contrast agents are absent during treatment, overriding contrast-enhanced CT numbers to tissue density minimizes potential range errors.
- For persistent contrast agents during treatment, proper density assignment is crucial to maintain treatment accuracy.
- This study aims to evaluate the dosimetric impacts of iodine-, barium- and gadolinium-based contrast agents on proton beam range.

Subjects and Methods:

- Treatment planning system (RayStation 2024A) was used
- A $40 \times 40 \times 40$ cm^3 water phantom with a $5 \times 5 \times 5$ cm^3 cubic insert centered at a depth of 5 cm
- A single field 5×5 cm^2 spread-out Bragg peak (SOBP) proton beam with a 5 cm modulation width and 2 Gy prescribed dose was optimized to the insert in the water phantom
- Contrast agents

1. Iodine-based: Imeron; 6, 15, 50 mg I/ml
2. Barium-based: Readi-Cat 2; 2, 5 % w/v
3. Gadolinium-based: Gadovist, Dotarem; 5, 10 mmol/L



Result:

- Distal range is defined as the depth of the 90% dose at the distal fall-off (R90).

	Iodine (Imeron; 6 mg I/ml)	Iodine (Imeron; 15 mg I/ml)	Iodine (Imeron; 50 mg I/ml)	Barium (Readi-Cat 2; 2% w/v)	Barium (Readi-Cat 2; 5% w/v)	Gadolinium (Gadovist & Dotarem; 5 mmol/L)	Gadolinium (Gadovist & Dotarem; 10 mmol/L)	Water
R90 (cm)	9.99	9.97	9.86	9.92	9.84	9.95	9.95	9.97
Range Shift (mm)	0.13	-0.05	-1.18	-0.50	-1.36	-0.24	-0.26	/

- High concentration iodine and barium induced range shift > 1 mm.
- Others demonstrated ranges comparable to water.
- SOBP shows similar results.
- For persistent contrast agents of unknown chemical composition during treatment, overriding to water is justified for low-to-medium concentration iodine, low-concentration barium and standard gadolinium.
- For high-concentration iodine and barium, a density override or margin expansion should be considered in high-precision treatments.