Proton Arc Therapy

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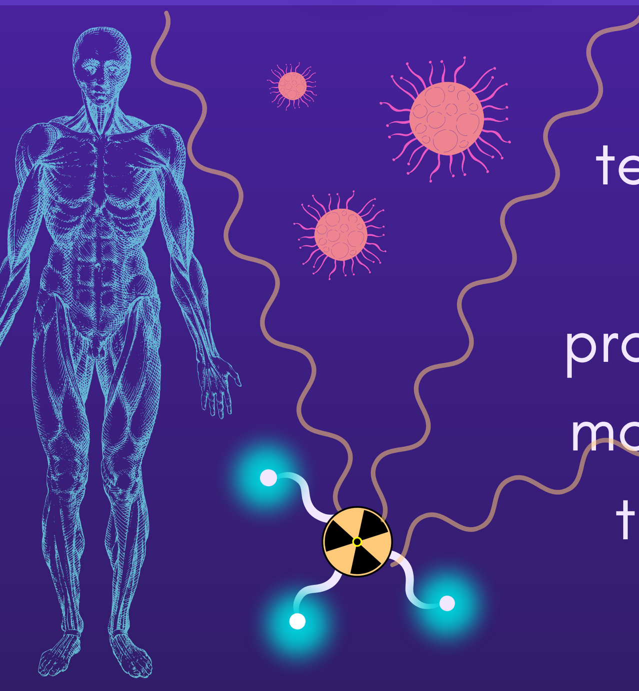
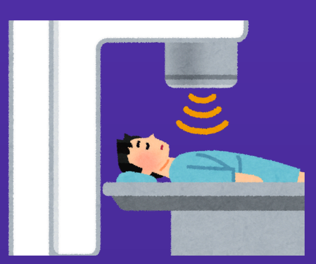
Cancer is a ruthless disease where cells grow uncontrollably and invade the body. Radiotherapy fights back with high-energy particles. Photon therapy has led the charge for decades, but proton therapy is rising fast. Now, a new era begins with Proton Arc Therapy — a dynamic, sweeping beam that targets tumors with unmatched precision.



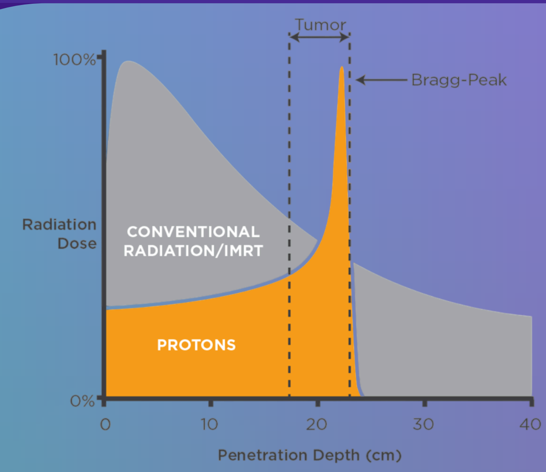
Proton Arc therapy (PAT) is a new beam delivery technique used in proton radiation therapy for different types of cancer. PAT delivers a continuous beam of protons that moves around the patient in an arc. This arc movement is beneficial in proton therapy, as it minimizes the dose to normal tissue while maintaining the volume the Bragg peak covers in the tumor.



WHATS IMPT? It's the most common delivery technique within radiation therapy. IMPT stands for Intensity Modulated Proton Therapy. Here, the proton beam is static and delivered in a few selected fields. In IMPT it's easier to control the depth of when the Braggs peak will occur.

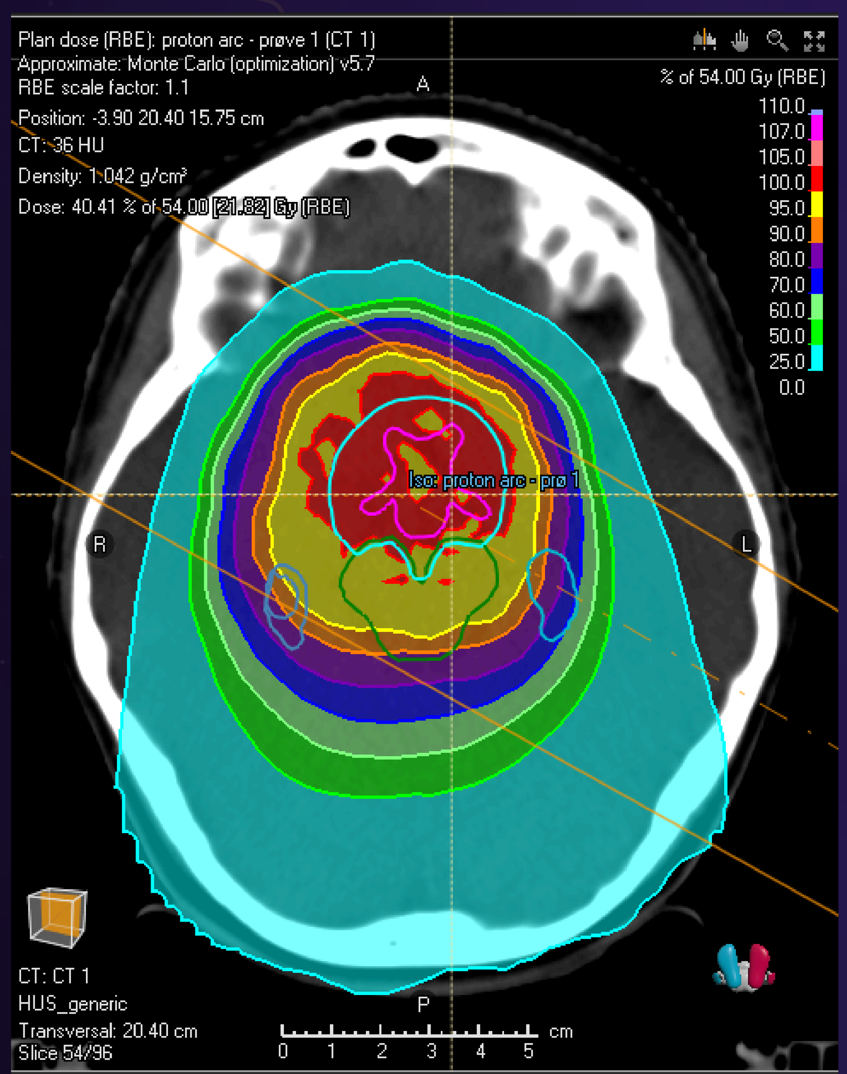
WHATS OAR? OAR stands for Organs At Risk. When a tumour is treated with radiation, it is key to shield the OARs so that the patient can function normally after treatment without any impairment.

WHATS BRAGG PEAK? Photons and protons differ in radiation therapy by how they deposit dose. Photon dose decreases exponentially with depth, while proton dose increases slowly to a sharp peak (Bragg peak) and then drops off. This makes protons ideal for treating tumors near critical structures, as they minimize radiation beyond the target



WHATS LET? Linear energy transfer (LET) describes how much energy an ionizing particle deposits per unit length as it travels through a medium. Higher LET leads to more cell death per unit dose, making it a measure of radiation quality. LET is important for evaluating dose, risks, and for modeling relative biological effectiveness (RBE) in treatment planning.

RESULTS PAT



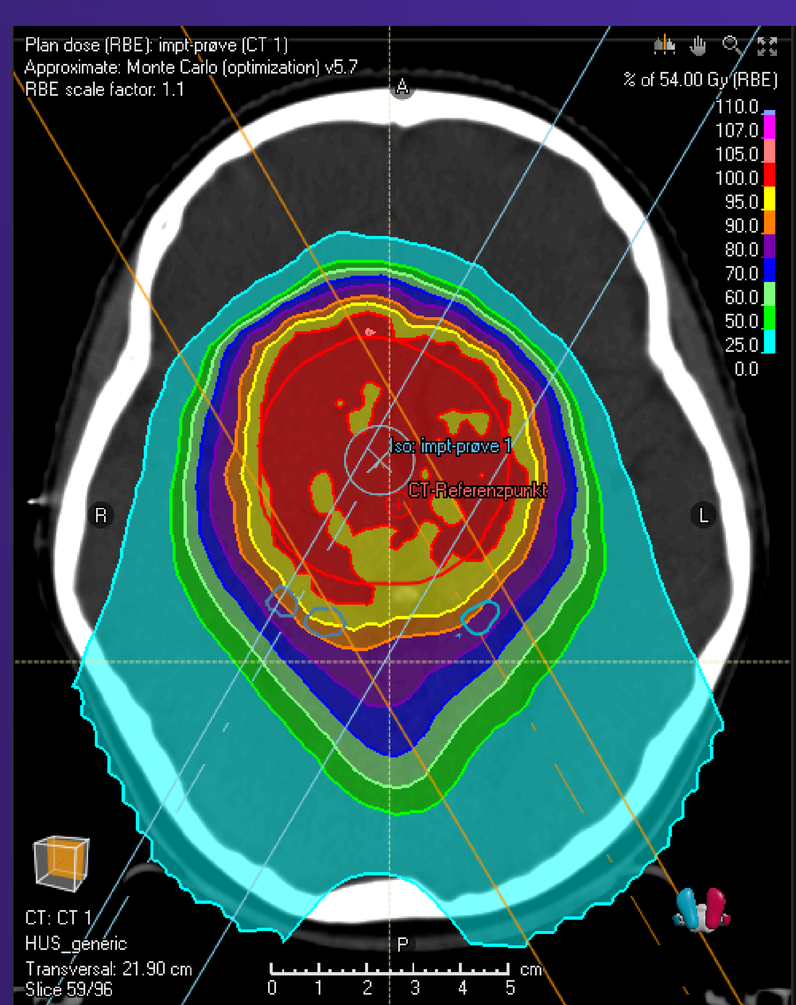
Organ	Goal	Dosage
Brainstem	D0.03 cm³ < 54 Gy	54.81 Gy !
Chiasma	D0.03 cm³ < 55 Gy	55.13 Gy !
CTV	D0.03 cm³ < 57.78 Gy	55.72 Gy ✓

CTV stands for Clinical Target Volume. This volume encompasses the tumour and any metastasis. The goals were given by the Haukeland University Hospital Guide. This CTV stands for the dosage the tumour gets at a volume of 0.03 cm³.

We did a trial-and-error on the parameters for the radiation to see what gave the best results. One can see from the table that not all goals were achieved. This is due to the complicated position of the tumour and the surrounding OARs. Since the chiasma and brainstem are located inside the tumour, it is important to create a balance which radiates the tumour but also spares damage to the OARs. Therefore, the given results are satisfactory enough, even though the radiation of the OARs are slightly above the goal. The parameters for PAT were then applied to the IMPT plan in the treatment planning system for comparison.

RESULTS IMPT

Organ	Goal	Dosage
Brainstem	D0.03 cm³ < 54 Gy	54.64 Gy !
Chiasma	D0.03 cm³ < 55 Gy	55.23 Gy !
CTV	D0.03 cm³ < 57.78 Gy	56.83 Gy ✓



In addition to clinical goals, there was also LET-weighted doses. These doses are a better indicator of the RBE than the non-evaluated. These results also showed that IMPT was slightly better than PAT.

Comparing the results, one can see that the IMPT clinical goals are slightly better with a thin margin. Is this margin big enough to conclude that IMPT is better than PAT? No. Since the difference is so minimal, one cannot conclude that IMPT is suficiently better than PAT. A slight change of parameters and constraints could lead to the PAT having better results than IMPT. A single do-over with the simulation and same parameters could also lead to a different result. Therefore one cannot conclude that one is neccesarily better than the other. However, we can conclude that they deliver quite similar results.

Read more here!

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