



Proton Arc Therapy with Modulating Proton Energies

Summary

Proton radiation therapy is a type of external beam radiotherapy that uses the energy distribution of protons to irradiate unwanted and diseased tissues. The proton beam can be directed and deposited by a physician in a designated 3-dimensional tissue volume with greater control and accuracy than traditional radiation therapies. However, due to patient and organ motion and depth, the precision of the beam is key for optimal treatment. In order to further improve the accuracy of proton therapy, a method called the Sweeping Arc with gantry angle dependent Modulation of Energy (SAME) therapy has been developed to provide additional rotation of the gantry which would then be modulated by a tertiary energy modulator (EM) to allow adaptive control and multiple angles of proton beam delivery.

Key Investigator

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Field

Radiation Oncology

Technology

Proton beam energy modulator to be used during active gantry movement

Technology Status

POC study completed

Status

Available for licensing

Patent Status

PCT/US2018/021541

UMB Docket Reference

BY-2017-075

External References

Langner et al. [A method to deliver energy modulated planar proton arc therapy \(EMPPAT\)](#) *Jour Proton Ther* (2017). 3:312.

Market

In the recent years, there has been a significant rise in the number of proton therapy centers globally with the US holding 40% of the facilities in the world. More research institutes and hospitals are investing in proton therapy to make the technology more accessible to patients. Currently, there are 27 proton beam facilities in operation in the US and another 10 under construction. The potential market of proton therapy is immense with projection of more than \$15 billion by the end of 2021.

Technology

SAME improves proton therapy by spreading incoming radiation doses throughout the target volume, improving the uniformity and reducing the uncertainty of the beam aim due to motion and depth. To illustrate the proof of principle of the SAME therapy, a phantom planning study was completed. In this study, proton arc therapy was simulated using 24 beams from equally spaced gantry angles. Each angle represented a control point where energy could be modulated according to predetermined depths inside the target volume with an energy modulator (EM) attached to the snout. A single energy was allowed from the cyclotron per plan and additional energies were produced using the EM, resulting in a plane inside the target volume that could be swept across as the arc is completed. The simulation demonstrated the feasibility of the SAME method and provided a possible alternative to use higher radiation doses while decrease the amount of off-target exposure to healthy tissue.

Advantages

- Increased number of angles give lower regional doses and shorter treatment time
- More uniform relative biological effect
- Less susceptible to motion and depth changes
 - Continuous energy change during Proton Therapy
 - Use of the dual-wedged energy modulator
 - Treatment planning using limited number of planes (2-3cm thick) which are around the rotation center in the target rather than distal end
 - Energy, weights, and position per angles can be further optimized to adjust to irregular contours, tissue inhomogeneity, plan quality and delivery efficiency

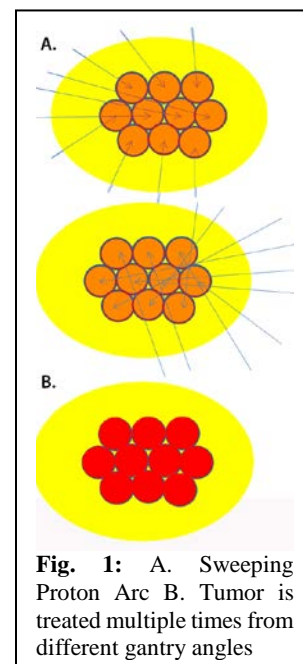


Fig. 1: A. Sweeping Proton Arc B. Tumor is treated multiple times from different gantry angles