Purpose: To develop a simple algorithm in designing the range modulation wheel to generate a very smooth Spread-Out Bragg peak (SOBP) for proton therapy.
Method and Materials: A simple algorithm has been developed to generate the weight factors in corresponding pristine Bragg peaks which composed a smooth SOBP in proton therapy. We used a modified analytical Bragg peak function based on Monte Carol simulation tool-kits of Geant4 as pristine Bragg peaks input in our algorithm. A simple METLAB $^{©}$ Quad Program was introduced to optimize the cost function in our algorithm.
Results: We found out that the existed analytical function of Bragg peak can't directly use as pristine Bragg peak dose-depth profile input file in optimization of the weight factors since this model didn't take into account of the scattering factors introducing from the range shifts in modifying the proton beam energies. We have done Geant4 simulations for proton energy of 63.4 MeV with a 1.08 cm SOBP for variation of pristine Bragg peaks which composed this SOBP and modified the existed analytical Bragg peak functions for their peak heights, ranges of R_0, and Gaussian energies σ_E. We found out that 19 pristine Bragg peaks are enough to achieve a flatness of 1.5% of SOBP which is the best flatness in the publications.
Conclusion: This work develops a simple algorithm to generate the weight factors which is used to design a range modulation wheel to generate a smooth SOBP in proton radiation therapy. We have found out that a medium number of pristine Bragg peaks are enough to generate a SOBP with flatness less than 2% . It is potential to generate data base to store in the treatment plan to produce a clinic acceptable SOBP by using our simple algorithm