**Optimization rotating shield brachytherapy treatment plan under treatment time budget**

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**Purpose**: To compute an optimized brachytherapy treatment plan under a given treatment time budget, to greatly reduce treatment time of rotating shield brachytherapy (RSBT) for cervical cancer without compromising plan quality, and to directly optimize D90 to further improve plan quality.

**Methods**: In the RSBT treatment planning system, we use single shield with 45° emission angle and radiation source 169Yb. We introduce a time budget constraint in the treatment planning and model the problem as a quadratic optimization which is solved by CPLEX. We investigate the tradeoff between treatment time and plan quality. We further introduce another novel second stage planning to achieve the following goals: (1) directly optimize D90; (2) explicitly constrain the scaling factor to be 1. The first model provides guidance for defining a hottest 90% region in high-risk clinical target volume (HR-CTV) and hottest 2 cm3 regions in organ at risks (OAR), and the second planning will directly maximize D90 under the tolerance constraints for OARs and treatment time constraint.

**Results**: We validate our algorithms via experiments on 5 patient cases. The results show that on average, when we reduce the delivery time from 45.85 min to 37.10 min and 28.14 min, the D90 will decrease from 88.12 Gy to 86.10 Gy and 81.98 Gy correspondingly. The results also show that on average, the second planning can further improve the D90 from 88.12 Gy to 90.47 Gy.

**Conclusion**: This work shows that significant reduction in treatment time is possible without compromising the quality of treatment plan. By introducing a second stage planning, the D90 can be further improved.

**Keywords: Brachytherapy, treatment planning optimization, D90 optimization**