

Determination of treatment efficiency of head-and-neck cancer based on TCP model

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External beam radiotherapy based on volumetric modulated arc radiotherapy technic delivery is widely used for the treatment of the locally advanced head-and-neck cancer (LAHNC). There are some approaches of irradiation of LAHNC, for example, simultaneous integrated boost (SIB) and sequential boost (SEQ) [1]. Analysis of the developed treatment plans based on tumour control probability (TCP) models (Niemierko's TCP model [2]) could help to estimate expected efficiency of the developed plans and to find optimal treatment schemes with respect to total dose value, fractional dose and overall treatment time (OTT).

In this study, the simultaneous integrated boost VMAT (SIB-VMAT) plans and sequential boost VMAT (SEQ-VMAT) plans were developed and obtained values of TCP based on the anatomical data of 11 patients.

The anatomical data of 11 patients with LAHNC (larynx, oropharynx and oral cavity) were used. For each patient two treatment plans were developed, SIB-VMAT (70 Gy to tumour, 50 Gy to lymph nodes, 25 fractions) and SEQ-VMAT (70 Gy to tumour, 50 Gy to lymph nodes, 35 fractions). The developed plans were analyzed using the Niemierko's TCP model with Maciejewski's parameters ($TCD_{50}=70.26$ Gy) taking into account dose-volume histograms and OTT.

The developed SIB-VMAT and SEQ-VMAT plans had the physical coverage of the CTV tumours more than 97% of prescribed dose delivered to more than 97% of the volume, except one. The average TCP value of SIB-VMAT was equal to 99.9% due to short OTT. The average value of TCP for SEQ-VMAT was equal to 61.0%. For one patient, the both SIB-VMAT and SEQ-VMAT plans showed zero expected efficiency due to CTV coverage 95%-95%.

According to the Niemierko TCP model using Maciejewski's parameters, the 50% efficiency of the treatment could be reached at EUD equal to $EUD = 70.26$ Gy, when the prescription dose values higher than 71-72 Gy or 70 Gy delivered in less than 35 fractions. The analysis of selected clinical trials showed that the reported results of treatment efficiency rather well correspond to the model predictions. However, the results of DVHs calculated for real patients' anatomical data showed that even small volumes of the tumour that were irradiated to doses less than 70 Gy in 35 fractions could significantly decrease the expected TCP value. The results of simulation and analysis of clinical practice show that the DVH of each patient should be analyzed on the expected TCP.

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The speaker is a student or young scientist

No

Section

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