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# COMPARING SIMULTANEOUS INTEGRATED BOOST AND SEQUENTIAL BOOST IN LARYNGEAL AND PAROTID GLAND HEAD AND NECK CANCER PATIENTS

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## Purpose/Introduction

Radiation therapy has a key role in treating patients with head and neck cancer. The most often employed radiation therapy technique for head and neck patients, due to the high concentration of vital organs near the tumour, is intensity-modulated radiation therapy (IMRT) either at several fixed gantry angles or as an arc therapy. There are two types of delivery: sequential (SEQ-IMRT) and simultaneous integrated boost (SIB-IMRT) [1]. SEQ-IMRT consists of two sequential plans. In the first plan the target structure is the low risk planning target volume (PTV-LR) and then, with a second plan, a boost dose is applied only to the high risk planning target volume (PTV-HR). The SIB-IMRT technique consists of a single plan with different radiation doses applied appropriately to the PTV-HR and PTV-LR [2]. Both techniques are wieldy used in practice. The aim of this study is to make a treatment planning comparison of both techniques by comparing the doses received by the organs at risk (OARs), keeping the target coverage radiobiologically equal [3]. For that purpose, two groups of patients were evaluated, for a total of thirty patients. The first group comprises of 15 patients with inoperable advanced stage laryngeal cancer, while the second group includes 15 parotid gland cancer post-op patients. In the laryngeal group, definitive radiotherapy was the main treatment, while in the parotid group radiotherapy was added as adjuvant postoperative treatment. The main side effect during the course of radiotherapy is mucositis, which is also a limiting factor for the completion of the radiotherapy treatment. A second side effect after the end of treatment is xerostomia, which affects the long term oral health of patients.

## Materials/Methods

Patient selection Thirty patients that were treated at the University Clinic of Radiotherapy and Oncology in Skopje, Macedonia were selected for this study. They were divided in two groups of 15 patients depending on the location of the primary tumour.

Treatment planning technique Static gantry IMRT plans with 6 MV photon beams were optimized and calculated using Eclipse 16.1 treatment planning system (Varian Medical) for Varian Clinac iX linear accelerator, 120 leaves MLC. The arrangement of the beams for the first plan of the SEQ-IMRT (target PTV-LR) and for the corresponding SIB-IMRT plan was the same and it consisted of 6-7 coplanar beams. The second plan of the SEQ-IMRT consisted of 5-6 beams arranged according to the position of PTV-HR and OARs.

Radiation dose and fractionation The goal was to achieve the same radiobiological effect for the PTVs with both techniques. Therefore, we calculated the Biological Effective Dose for the SEQ-IMRT treatment according to [4] and then considering the rate of proliferation of the tumour and its type, we calculated the dose/fractions that should be used in SIB-IMRT technique. In the table in Fig. 1 we present the doses and fractions prescribed to the different targets using both techniques for the two localizations.

Plan evaluation and comparison The plans were optimized to provide proper coverage of the target volumes with normalization of 100% at dose mean. Evaluation of the plans was made using DVH as follows:

- First criteria was 98 % coverage of the volumes of PTVs with 95 % of the prescribed dose.
- For evaluation of the OARs, recommendations from QUANTEC [5] were followed. For oral cavity, recommendation found in literature [6] was followed. We evaluated the spinal cord, oral cavity, parotid glands and larynx. Since the fractionation in the plans was different, EQ2 doses were used to compare the OARs. In the table in Fig.2 we provide the used EQ2 dose limits.

The coverage of the OARs was compared with the nonparametric two-tailed Wilcoxon signed-rank test for paired values. Statistical significance was assumed at $p \leq 0.05$.

# Results

In the table in Fig.3 we present the results for percentage of the volume receiving 95% of the prescribed dose for all the target structures, for both techniques and localizations. All results fulfilled the 98% coverage criterion with 95% dose.

In the table in Fig.4 we present the evaluated OAR doses and volumes for both techniques, for patients with parotid gland cancer. The OAR doses were within the limits for both techniques, with oral cavity and larynx receiving smaller doses with the SEQ-IMRT technique than with the SIB-IMRT technique.

For laryngeal cancer, as presented in the table in Fig.5, the doses received by the OARs were also in limits with the exception of the parotids. Again, the results show that the SEQ-IMRT technique gives smaller doses to the oral cavity and to the parotids.

# Discussion

The dose to PTV-LR and PTV-HR in both techniques was prescribed in a way that the radiobiological effect in both cases is equivalent, taking in consideration the proliferation of the tumours. The optimization was performed in such a way that more than 98% of the volumes of PTVs were covered with 95% of the prescribed dose. In laryngeal cancer, the dose to the parotids was out of limit because part of the PTV-LR extended in the parotids. However, the position of parotid glands in this case was not overlapping with PTV-HR, thus allowing the SEQ-IMRT to better spare the parotids in comparison to SIB-IMRT. Oral cavity was also spared more in this case. In parotid gland cancer the PTV-HR is concentrated to only one parotid and therefore there is substantial sparing of the OARs and they are all within limits. Again SEQ-IMRT spares the larynx and the oral cavity better, which is not seen in the contralateral parotid.

# Conclusions

From this research we can conclude that SEQ-IMRT is better at sparing the OARs when treating these two types of cancer. However, in all cases when one of the techniques conformed to the OAR limits, so did the other. Therefore, when deciding on the optimal technique, additional factors should be taken into account as well, such as the position and delineation of the PTVs, the volume and position of the OARs relative to the PTVs etc. One strong point for SIB-IMRT technique for a department with a heavy patient load is that the overall treatment time for

SIB-IMRT technique is 3-5 days shorter. Therefore, the clinical choice of the technique should include all the patient specific, but also department specific factors.

# References


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| Type of cancer | Techniques | SEQ-IMRT | SIB-IMRT |
|---|---|---|---|
| Parotid gland cancer | Total dose to PTV-LR (Gy) | 50 | 54 |
| | Total dose to PTV-HR (Gy) | 66 | 63 |
| | Dose per fraction of PTV-LR (Gy/fraction) | 2 | 1.8 |
| | Dose per fraction of PTV-HR (Gy/fraction) | 2 | 2.1 |
| | Number of fractions | 33 | 30 |
| Laryngeal cancer | Dose to PTV-LR (Gy) | 50 | 54 |
| | Dose to PTV-HR (Gy) | 70 | 66 |
| | Dose per fraction of PTV-LR (Gy/fraction) | 2 | 1.8 |
| | Dose per fraction of PTV-HR (Gy/fraction) | 2 | 2.2 |
| | Number of fractions | 35 | 30 |

*Table 1: The prescription dose of SEQ-IMRT and SIB-IMRT techniques*

| OAR | | Dose criteria |
|---|---|---|
| Spinal cord | | $D_{max} < 50$ Gy |
| Parotid glands | Unilateral | $D_{mean} < 20$ Gy |
| | Bilateral | $D_{mean} < 25$ Gy |
| Oral cavity | | $D_{mean}$ (excluding PTV) < 40 Gy |
| Larynx | | $D_{mean} < 44$ Gy |
| | | V50 < 27 % |

*Table 2: The dose criteria for OARs*

| | | SEQ-IMRT | | SIB-IMRT | |
|---|---|---|---|---|---|
| Organ | Target | Mean ± SD | Median | Mean ± SD | Median |
| Parotid glands cancer | PTV-LR | 99.7 ± 0.2 | 99.8 | 99.9 ± 0.2 | 100 |
| | PTV-HR | 99.4 ± 0.3 | 99.5 | 99.6 ± 0.3 | 99.7 |
| Laryngeal cancer | PTV-LR | 99.8 ± 0.2 | 99.9 | 99.9 ± 0.2 | 99.9 |
| | PTV-HR | 99.8 ± 0.2 | 99.8 | 99.8 ± 0.3 | 100 |

*Table 3: Coverage of the target volumes for both techniques*

| | | SEQ-IMRT | | SIB-IMRT | | |
|---|---|---|---|---|---|---|
| Organ | Dose criteria | Mean ± SD, Gy | Median, Gy | Mean ± SD, Gy | Median, Gy | p-value |
| Spinal cord | $D_{max}$ < 50 Gy | 34.9 ± 2.5 | 35 | 36.4 ± 2 | 36.4 | - |
| Oral cavity-PTV | $D_{mean}$ < 40 Gy | 21.8 ± 3.2 | 21.7 | 23.4 ± 3.7 | 22.7 | .003 |
| Larynx | $D_{mean}$ < 44 Gy | 23.5 ± 2.5 | 24 | 27.2 ± 3.4 | 27.1 | < .001 |
| Larynx | V50 < 27 % | 3 ± 1.6 | 3.1 | 13.4 ± 4.4 | 11.6 | < .001 |
| Parotid gland | $D_{mean}$ < 20 Gy | 5.5 ± 1 | 5.4 | 5.2 ± 1.2 | 5.1 | .20 |

*Table 4: The dose to OARs for SEQ-IMRT and SIB-IMRT in parotid glands cancer patients*

*Table 5: The dose to OARs for SEQ-IMRT and SIB-IMRT in laryngeal cancer*

**Scientific field:**

Radiation therapy

**Preferred presentation mode:**

Poster