Patient alignment with and without surface-guided radiotherapy system in SRS treatments.

Michalis Psarras[1], Theodoros Stroubinis[1], Despoina Stasinou[1], Anna Zygogianni[2], Maria Protopapa[1], Kalliopi Platoni[3]

1. Department of Radiation Oncology and Stereotactic Radiosurgery, Mediterraneo Hospital, Athens, Greece
2. 1st Department of Radiology, Radiation Oncology Unit, National & Kapodistrian University of Athens, Athens, Greece
3. 2nd Department of Radiology, Medical Physics Unit, National & Kapodistrian University of Athens, Athens, Greece.

Introduction

Surface-Guided Radiotherapy (SGRT) is a state-of-the-art technique that improves the patients' positioning against the conventional technique of 3 tattoo markers and alignment lasers. Furthermore, SGRT provides the feature of the patient's monitoring for intra-fraction motion, and the capability of the beam holding if the patient's intra-fraction motions are out of the specific tolerance levels in terms of the translational axes and rational angles[1-3].

Aim

The goal of this retrospective study was the evaluation of set-up errors and efficiency of patients' positioning, with conventional against SGRT technique in Stereotactic RadioSurgery (SRS) treatments.

Materials And Methods

Twenty-Eight patients with brain malignancies, treated with single-isocenter SRS technique using HyperArc algorithm, were randomized in two groups of fourteen each. Group_I included patients that were aligned with lasers according to the 3-point markers of the QFix Encompass immobilization system. Group_II included patients that were positioned according to AlignRT SGRT system. The treatments were delivered in Varian TrueBeam Edge Linac. Patients' positioning was evaluated with Cone-Beam Computed Tomography (CBCT). The CBCT six-degree translational and rotational errors were recorded for each patient. The Root Mean Square (RMS) was calculated. The non-parametric Mann-Whitney Wilcoxon test was performed for statistical analysis of the differences between each groups' setup errors, using SPSS software Version 25.0. A level of p-value<0.05 was defined as statistically significant.

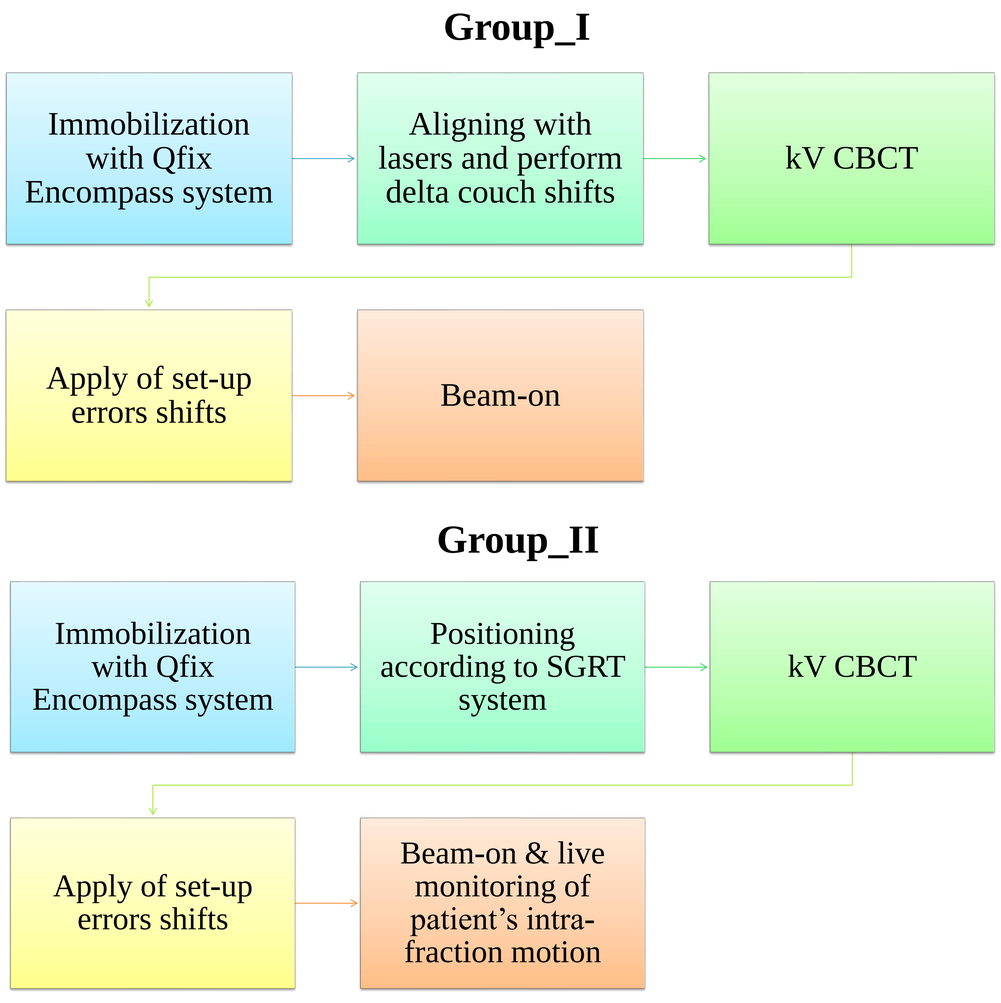

Figure 1: Diagrams of SRS patient's workflow of conventional patients' positioning technique VS. SGRT .

Results

Table 1: Conventional technique Setup errors

Patients #	Ver (mm)	Lng (mm)	Lat (mm)	RMS (mm)	Pitch (°)	Roll (°)	Rtn (°)	Set-up Time (min)	Notes
1	0.7	1.6	0.8	1.92	0.4	2.6	2.3	42	5 CBCT
2	2	1.1	0.4	2.32	1.2	2.8	2.5	19	3 CBCT
3	1	0.3	0.5	1.16	0.2	0.8	1.3	6	
4	2	1.1	1.1	2.53	0.5	1	0	9	
5	0.6	1.6	0.9	1.93	0.2	0.3	0.7	9	
6	0.9	2.7	0.7	2.93	0.4	0	0.2	9	
7	1.3	1.8	0.5	2.28	0.5	0.4	0.3	8	
8	1.2	1.8	0.6	2.24	0.5	0.7	0.3	8	
9	1	0.3	1.5	1.83	0.5	1.1	0.3	8	
10	0.7	0.1	0.9	1.14	0.7	0.7	1.1	8	
11	1.2	0.4	1.3	1.81	0	0.3	0.5	14	2 CBCT
12	1.9	0.5	1.6	2.53	0.5	0.7	1.2	7	
13	1	1	1	1.73	0.2	0.6	0.1	9	
14	1.7	1.3	1.7	2.73	1.7	0.3	1.4	20	2 CBCT
Median	1.1	1.1	0.9	2.09	0.5	0.7	0.6	9	

Table 2: SGRT technique Setup errors

Patients #	Ver (mm)	Lng (mm)	Lat (mm)	RMS (mm)	Pitch (°)	Roll (°)	Rtn (°)	Set-up Time (min)	Notes
15	0.8	0.7	0.1	1.07	0.8	0.5	0.9	7	
16	0.5	2	0.6	2.15	0.2	0.5	0.8	8	
17	1.6	2.6	0.4	3.08	0.5	1	0.2	8	
18	3	0.4	0.1	3.03	0.5	0.2	1.1	6	
19	0.3	1.1	0.9	1.45	1	0.5	0.4	19	
20	0.5	0	0.2	0.54	0.8	0.2	0.1	15	
21	0.3	0.5	0	0.58	1	0.8	0.8	11	
22	0	0.8	0.1	0.81	0.4	0.7	0.1	9	
23	2.6	0.4	0.7	2.72	0.9	0.9	0.3	14	
24	1.5	1.4	0.4	2.09	1.1	0.5	0.9	9	
25	2.8	2.8	0.2	3.96	0.6	0.2	0.4	5	
26	0.3	3.9	0.1	3.91	0.1	0.1	0.9	7	
27	1.1	1.9	1.3	2.55	0.1	0.3	0.6	22	2 CBCT
28	2.7	0.3	0.8	2.83	0.6	0.3	0.6	13	
Median	0.95	0.95	0.3	2.35	0.6	0.5	0.6	9	

No statistically significant differences were observed between the two methods for set-up errors, except for lateral direction (p-value=0.002). For Group_I, in four cases the RTTs re-entered the treatment room to re-position the patients leading to the acquisition of at least two CBCTs. Specifically, two patients were re-imaged with two CBCTs, one with three and one with five. On the contrary, for Group_II only one patient was re-positioned a second time.

Conclusion

- The SGRT system is reliable for patient positioning in SRS, having similar or better performance with the conventional laser alignment.
- Despite having the same median setup times, the SGRT alignment technique proved to be more efficient than the 3-point markers one, in terms of the number of the CBCTs acquired for the positioning to be acceptable.

References

1. Batista, V., et al., Clinical paradigms and challenges in surface guided radiation therapy: Where do we go from here? Radiother Oncol, 2020. 153: p. 34-42.
2. Hoisak, J.D.P. and T. Pawlicki, *The Role of Optical Surface Imaging Systems in Radiation Therapy.* Semin Radiat Oncol, 2018. **28**(3): p. 185-193.
3. Freislederer, P., et al., *Recent advanced in Surface Guided Radiation Therapy.* Radiat Oncol, 2020. **15**(1): p. 187.

Contact Information

Michalis Psarras, MSc.
Email: mixpsarras@gmail.com