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Dosimetric evaluation of patient setup errors due to uncertainties during IMRT for head and neck cancer cases

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SUMMARY

Background: IMRT become popular because dose escalation to the target can be done while sparing adjacent normal tissues. Intensity-modulated radiation therapy tends to produce steep absorbed-dose gradients between the target volume and the OAR. This study was done to determine the error during RT on positioning displacement for patients treated for head and neck cancer. We tried to find the magnitude of daily setup errors to determine the set up error cases. The results can help physicians to determine the most suitable margin for head and neck cases.

Results: Data from 20 patients calculated. The Right/Left direction as X direction, Anterior/Posterior direction as Y shift and Up/Down direction as Z shift. Average shift for all fractions calculated to be 0.05 cm, 0.08 cm and -0.02 cm as RT/LT, Ant/Post and Up/Down shifts.

Conclusions: To reduce setup errors in patients with H&N cancer receiving RT. The use of on-line image-guided radiotherapy is recommended to increase accuracy.

Key words: Adaptive Radiotherapy,Head and Neck Cancer; Image-guided Radiotherapy; Setup Error; IMRT

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INTRODUCTION

Radiation Therapy (RT) is commonly used as part of multiple modality treatment for prostate cancer. Intensity-Modulated Radiation Therapy (IMRT) has become increasingly popular because dose escalation to the target can be done while sparing adjacent normal tissues. Several factors such as the accuracy of the immobilization device change in body contours, and tumor regression could lead to setup uncertainties during RT, all of these factors need to be minimized with the use of special approaches. Image-Guided Radiation Therapy (IGRT) can be used to correct and quantify geometrical uncertainties for daily setup [1].

IMRT target contours in three dimensions, often with six independent values-anterior, posterior, medial, lateral, superior, inferior [2]. Intensity-modulated radiation therapy tends to produce steep absorbed-dose gradients between the target volume and the OAR. Having realistic margins for both the tumor volume and any OAR. Factors affecting margin requirements to define the PTV include uncertainty of patient positioning, mechanical uncertainty of the equipment (e.g. gantry sagging), dosimetric uncertainties (e.g. penetration of the beam), the use of motion management techniques such as gating, image transfer errors from CT and simulator to the treatment unit, and human factors. These factors will vary from center to center, and, within a given center, from machine to machine and from patient to patient. The use of patient immobilization devices, the application of quality-assurance programs, and the skill and experience of the radiographers/radiotherapists are also important and must be taken into account. Additionally, the use of different image-guidance systems or other uncertainty-reduction techniques can significantly alter the size of the required margins.

An error is defined as; The difference between the measured (observation) value and the actual (true) value [3-12].

Errors can be divided into three categories:

- Personal Error
- Systematic Error
- Random Error

Systematic Error

The type of error arises due to defect in the measuring device or its data handling system, or because the instrument is

wrongly used by the experimenter. Generally, it is called "ZERO ERROR". It may be positive or negative error and can be removed by correcting measurement device. [13-14]

Systematic errors may be of four kinds:

- Instrumental: For example, a poorly calibrated instrument such as a thermometer that reads 102^0C when immersed in boiling water and 2^0C when immersed in ice water at atmospheric pressure. Such a thermometer would result in measured values that are consistently too high.
- Observational: For example, parallax in reading a meter scale.
- Environmental: For example, an electrical power that causes measured currents to be consistently too low.
- Theoretical: Due to simplification of the model system or approximations in the equations describing it. For example, if your theory says that the temperature of the surrounding will not affect the readings taken when it actually does, then this factor will introduce a source of error [13].

Random Error

The error produced due to sudden change in experimental conditions. For example: During sudden change in temperature, change in humidity, fluctuation in potential difference (voltage). It is an accidental error and is beyond the control of the person making measurement. Random errors are positive and negative fluctuations that cause about one-half of the measurements to be too high and one-half to be too low. Sources of random errors cannot always be identified. Possible sources of random errors are as follows:

- Observational. For example, errors in judgment of an observer when reading the scale of a measuring device to the smallest division.
- Environmental. For example, unpredictable fluctuations in line voltage, temperature, or mechanical vibrations of equipment.

Random errors, unlike systematic errors, can often be quantified by statistical analysis; therefore, the effects of random errors on the quantity or physical law under investigation can often be determined. The precision is limited by the random errors. It may usually be determined by repeating the measurements.

Random errors are errors which fluctuate from one measurement to the next. They yield results distributed about some mean value. They can occur for a variety of reasons. They may occur due to lack of sensitivity. For a sufficiently a small change an instrument may not be able to respond to it or to indicate it or the observer may not be able to discern it. They may occur due to noise. There may be extraneous disturbances which cannot be taken into account. They may be due to imprecise definition. They may also occur due to statistical processes such as the roll of dice [9,12].

This study was done to determine the error during RT on positioning displacement for patients treated for Head and Neck. We tried to find the magnitude of daily setup errors to determine the set up error cases. The results can help physicians to determine the most suitable margin for H&N cases.

METHODS

Patients

We used data from 20 patients treated for Head and Neck at Our radiotherapy center. All patients received IGRT with daily on-line kilovoltage imaging with weekly Cone Beam Computed Tomography (CBCT) to correct the treatment position. No patients had ART planning before a prescribed dose of (70) Gy.

Treatment Planning

To enhance the accuracy of the daily irradiated position, simulation using a Computed Tomographic (CT) scan simulator (GE ct) was made. The scans consisted of a protocol with a 2.5-mm-slice thickness, and Marks on the patients' skin were drawn using setup lasers to facilitate an accurate daily position.

For patients receiving definitive RT, the Clinical Target Volume (CTV) was defined as the gross tumor volume plus a margin of 7 mm posteriorly, and 10 mm in all other directions. All patients underwent IMRT plans and all plans were carried out using a commercial radiation treatment planning system (Elekta).

Treatment verification

All patients were treated with IGRT with linear accelerator equipped with an on-line On-Board Imaging (OBI) function including two-dimensional (2D) kilovoltage (kV) images and three-dimensional (3D) CBCT. The technicians set up the patients on a couch in the simulation room according to the marks drawn on their bodies. On-line OBI images (2D kV images daily and 3D CBCT weekly) were taken and sent to the station where they could be registered to digitally reconstructed radiographs from the treatment planning images. Two technicians compared these paired images by correlating the bony anatomy and corrected the difference by shifting the couch translationally before treatment. Then, physician confirmed the corrected on-line images. Anatomic reference landmarks included at least three visible bony structures.

Setup displacement

After image registration, quantification of alignment data for daily OBI in the Superior-Inferior (SI), Anterior-Posterior (AP), and Medial-Lateral (ML) directions, and Couch Rotation (CR) for all patients were collected. For each direction, the recorded setup displacements were composed of two components, Systematic Errors (SE) and Random Errors (RE). The SE was the deviation between the simulated patient position and the average patient position, while the RE was that which occurred between different fractions.

RESULTS

Setup errors are modelled as shifts of the beam isocenter. A shift of the beam isocenter leads to a non-rigid shift of the dose distribution. Small setup errors might thus lead to large displacements of spots that travel close to and in parallel with steep density gradients, such as along bone edges.in our study average data from 20 patient during all fractions calculated in table (1).The Right/Left direction as X direction, Anterior/Posterior direction as Y shift and Up/Down direction as Z shift

as shown. Then drawing the relation between X, Y and Z shift as a function of no. of fractions then average shift for all fractions calculated to be (0.05) cm, (0.08) cm and (-0.02) cm as RT/LT , Ant./Post. And Up/Down shifts.

Tab. 1. Bet Shifts and no. of fractions. Shifts were found that it range from 1 mm to 4 mm in X-direction and from 1 mm to 2 mm in Y and from 2 mm to 5 mm in Z direction (between + and in all directions) . Then we applied shifts to plan on planning system and recording differences occurred on DVH's of targets and critical organs

No.	X_{avg}	Y_{avg}	Z_{avg}
1	0.39	-0.07	0.04
2	-0.04	0.04	-0.12
3	-0.05	0	-0.0 1
4	-0.0 1	0.04	0.23
5	-0.03	0 .11	-0.14
6	0.08	0 .11	-0.1
7	-0.0 1	0.13	0.0 1
8	0.07	0.15	-0.15
9	0.1	0.15	-0.23
10	0.07	0.19	-0.07
11	0.03	0.08	-0.03
12	0.03	0.13	-0 .10
13	0.03	0.12	-0.13
14	0.06	0.1	-0 .07
15	0.05	0.12	-0.04
16	0.1	0.23	-0.1
17	0.03	0.12	-0.11
18	0.04	0 .11	-0.11
19	0.07	0 .11	-0.04
20	0.07	0.15	-0.04
21	0.03	0.07	0.0 1
22	0.07	-0.03	-0.1
23	0.08	0.0 1	0.03
24	0.05	0.06	0.02
25	0	0.06	-0.05
26	0	0.03	0
27	0.0 1	0.07	0.07
28	0.05	0.09	0.0 1
29	0.05	0.04	0.48
30	0.05	0.05	0.03
31	0.06	0.03	0.02
32	0.04	0.02	0.0 1
33	0.03	0.04	0.03
34	0.1	0.02	0.0 1
35	0.05	0.0 1	-0.0 1

Tab. 2. Changes occurred to dose delivered to 98% volume of PTV45 with different shifts

	PTV54Gy	98%	
Shift	dose X	dose Y	dose Z
1	50.877	50.766	50.878
2	50.887	50.148	50.814
3	50.775	49.521	50.585
4	50.704	48.849	50.398
5	50.323	47.453	50.358
6	50.09	45.515	49.88
7	49.801	41.556	49.575
8	49.251	38.581	49.195
-1	50.651	50.881	50.833
-2	50.622	50.626	50.617
-3	50.368	50.258	50.442
-4	50.211	49.839	50.197
-5	49.9	49.391	49.653
-6	49.499	49.072	49.096
-7	49.067	48.446	48.566
-8	48.594	47.811	47.924

Tab. 3. Changes occurred to dose delivered to 98% volume of PTV60 with different shifts

	PTV60Gy	98%	
Shift	Dose X	Dose Y	Dose Z
1	55.661	56.07	55.574
2	55.228	56.059	55.287
3	54.526	55.965	54.89
4	53.73	55.614	54.156
5	52.545	55.248	53.25
6	51.185	54.696	52.314
7	49.7	53.992	51.38
8	48.118	53.267	50.179
-1	55.506	55.193	55.714
-2	54.939	54.485	55.425
-3	54.07	53.649	54.904
-4	64.754	52.196	54.494
-5	51.407	50.62	53.78
-6	49.74	48.922	52.985
-7	57.891	47.437	52.156
-8	45.739	45.268	51.238

Tab. 4. Changes Max dose of LT lens with different shifts

	PTV70Gy	98%	
shift	dose X	dose Y	dose Z
1	64.408	64.925	63.979
2	64.299	65.127	63.39
3	63.957	64.943	62.569
4	63.36	64.656	61.401
5	62.208	64.251	60.512
6	61.513	63.624	59.426
7	59.905	62.905	58.138
8	58.205	62.351	56.817
-1	64.322	63.746	65.025
-2	64.132	63.034	64.977
-3	63.365	62.144	64.94
-4	62.7	60.594	64.628
-5	61.124	59.544	64.226
-6	59.481	58.339	63.363
-7	57.891	57.56	62.542
-8	55.793	56.431	61.652

Tab. 5. Changes Max dose of LT lens with different shifts

	It lens	11.93GY	
shift	Max dose	Max dose Y	Max dose Z
1	11.887	14.616	12.956
2	12.318	18.333	12.959
3	11.993	21.774	12.839
4	12.472	23.395	12.643
5	12.282	25.196	13.765
6	12.725	27.55	13.018
7	12.688	30.325	13.234
8	13.331	31.743	13.754
-1	12.495	10.77	11.97
-2	11.784	9.408	11.766
-3	11.729	7.703	11.936
-4	12.381	5.8	11.667
-5	12.108	5.149	11.679
-6	11.542	4.169	11.719
-7	10.959	4.427	11.45
-8	10.872	4.035	11.667

Tab. 6. Changes occurred to Max dose of RT lens with different shifts

	Rt lens	5.492 GY	
shift	Illax dose	Illax dose	Illax dose
1	5.213	6.331	5.107
2	5.485	7.724	5.5
3	5.302	8.7	5.225
4	5.187	10.367	6.079
5	5.25	10.44	5.993
6	4.908	12.508	5.681
7	5.194	15.007	6.057
8	5.434	17.473	5.708
-1	5.624	5.09	5.678
-2	6.027	4.733	5.578
-3	5.712	4.214	5.777
-4	5.305	3.524	5.609
-5	6.499	3.77	5.936
-6	6.566	3.539	5.397
-7	5.853	3.927	5.518
-8	6.227	3.085	5.506

Tab. 7. Changes occurred to Max dose of Optic Chiasm with different shifts

	optic chiasm	35.97 GY	
shift	Max dose X	Max dose Y	Max dose Z
1	35.257	40.796	35.884
2	36.394	48.758	34.347
3	35.797	51.74	33.358
4	36.405	53.457	33.121
5	35.329	56.585	32.5
6	34.644	58.335	32.544
7	34.218	59.904	32.449
8	37.179	59.958	29.524
-1	36.28	31.255	36.102
-2	35.08	27 .848	36.553
-3	35.804	24.333	36.743
-4	36.559	20.367	37.535
-5	34.425	18.204	37.309
-6	35.884	16.471	37.698
-7	33.829	15.847	37.756
-8	34.841	13.338	38.717

Tab. 8. Changes occurred to Max dose of Brain stem with different shifts

	Brain stem	51.476 GY	
shift	Max dose X	Max dose Y	I/lax dose
1	51.033	51.413	51.213
2	51.266	51.78	49.893
3	51.744	52.131	49.453
4	54.656	52.48	49.458
5	54.648	52.909	49.655
6	54.4	53.118	48.344
7	55.876	53.558	48.126
8	55.915	54.742	47.992
-1	51.327	53.683	51.254
-2	52.087	51.841	52.767
-3	53.902	51.65	53.098
-4	54.455	51.602	54.192
-5	55.176	50.448	55.52
-6	56.864	50.392	57.59
-7	58.499	50.064	59.458
-8	59.813	49.592	60.72

Tab. 9. Changes occurred to Max dose of Spinal cord with different shifts

	spinal cord	39.516GY	
shift	Max dose X	ax dose	\/lax dose
1	39.953	39.88	39.453
2	41.217	40.281	38.59
3	43.131	39.985	36.991
4	43.554	39.764	36.808
5	45.131	39.836	36.79
6	46.495	42.752	36.234
7	47.607	40.312	35.479
8	49.161	41.485	35.196
-1	41.093	40.191	41.116
-2	41.453	40.519	42.919
-3	41.119	40.602	45.022
-4	42.64	39.919	47.207
-5	43.938	41.707	48.363
-6	45.044	42.066	49.213
-7	45.117	41.436	50.289
-8	47.221	41.665	53.792

Tab. 10. Changes occurred to Max dose of optic chiasm PRV with different shifts

	Optic chiasm	PRV	34 Gy
Shift	Max dose X	Max dose	Max dose Z
1	36.882	41.729	36.372
2	36.394	49.672	35.185
3	36.023	51.842	34.591
4	36.405	54.931	33.298
5	35.916	58.258	34.4
6	35.467	58.849	33.842
7	34.802	61.59	33.977
8	38.27	61.197	30.738
-1	36.28	32.268	36.971
-2	35.841	28.971	36.349
-3	35.804	25.866	36.916
-4	36.684	20.848	38.199
-5	35.108	18.204	37.309
-6	36.352	17.285	37.698
-7	34.87	16.25	38.967
-8	35.763	13.872	38.895

Tab. 11. Changes occurred to Max dose of Brain stem PRV with different shifts

	B S.PRV	45.6 Gy	
Shift	\/lax dose	fi/lax dose	\/lax dose
1	55.444	54.46	1 54.059
2	56.763	55.12	1 52.819
3	55.937	56.145	51.913
4	57.057	56.663	51.458
5	58.347	57.942	51.158
6	60.711	58.035	50.305
7	62.574	61.039	49.788
8	62.764	60.852	50.65
-1	54.177	53.822	55.658
-2	55.823	53.857	56.914
-3	58.35	53.779	58.502
-4	58.955	53.722	59.74
-5	60.527	52.636	63.105
-6	62.401	52.589	64.788
-7	65.043	53.287	63.783
-8	67.232	54.344	64.363

Tab. 12. Changes occurred to Max dose S.C. PRV with different shifts

	S.C.PRV	49.9GY	
Shift	Max dose	Max dose	Max dose
1	50.282	49.159	48.046
2	52.184	48.399	47.596
3	53.176	48.53	1 44.38
4	54.685	47.983	44.108
5	54.536	47.746	42.577
6	57.125	49.087	40.573
7	59.731	48.98	39.647
8	58.396	48.569	38.95
-1	49.157	49.726	51.042
-2	50.817	51.092	51.484
-3	51.076	50.343	53.242
-4	53.061	51.125	54.535
-5	53.857	51.834	56.308
-6	56.933	51.633	61.403
-7	56.416	50.405	61.255
-8	58.762	51.567	63.104

Tab. 13. Changes occurred to Max dose of LT. Parotid with different shifts

	Lt Parotid	Mean	25 Gy
Shift	Dose X	Dose Y	Dose Z
1	27.595	26.237	26.436
2	29.488	26.824	26.844
3	31.315	27.195	27.393
4	33.341	27.502	28.095
5	35.428	27.99	1 28.752
6	37.597	28.413	29.489
7	39.612	29.017	30.379
8	41.882	29.624	31.234
-1	24.345	25.656	25.627
-2	22.743	25.578	25.472
-3	21.365	25.235	25.32
-4	20.074	24.973	25.182
-5	18.95	24.825	25.207
-6	17.838	24.582	25.298
-7	16.957	24.609	25.507
-8	16.046	24.466	25.697

Tab. 14. Changes occurred to Max dose of RT. Parotid with different shifts

	RT parotid	25.3GY	
Shift	Max Dose	Max Dose	Max Dose
1	24.297	26.25	26.366
2	22.805	26.792	26.96
3	21.545	27.244	27.602
4	20.154	27.72	28.16
5	18.895	28.336	29.011
6	17.89	28.828	29.739
7	16.907	29.49	130.622
8	15.994	30.018	31.246
-11	27.38	25.258	25.285
-2	29	24.803	24.806
-3	30.646	24.399	24.482
-4	32.304	24.082	24.189
-5	33.959	23.623	23.859
-6	35.7	23.311	23.796
-7	37.45	23	1 23.73
-8	39.178	22.743	23.773

Tab. 15. Changes occurred to Mean dose of LT. Cochlea with different shifts

	Lt coch lea	mean 26.9	Gy<45
Shift	Dose X	Dose Y	Dose Z
1	27.895	27.592	26.075
2	30.316	30.82	25.808
3	32.448	33.476	24.966
4	35.475	34.57	1 24.639
5	37.859	37.309	24.228
6	38.97	40.127	23.123
7	42.462	46.016	23.02
8	43.021	50.14	23.711
-1	25.225	25.77	27.507
-2	24.664	26.077	28.843
-3	24.345	26.113	29.139
-4	25.252	26.065	30.747
-5	24.71	25.506	31.586
-6	24.431	26.337	32.662
-7	25.501	26.26	1 34.268
-8	25.484	27.122	35.478

Tab. 16. Changes occurred to Mean dose of RT. Cochlea with different shifts

	Rt Cochlea	42 Gy	
Shift	Dose X	Dose Y	Dose Z
1	39.249	43.052	42.22
2	37.369	44.969	41.235
3	37.308	46.934	40.955
4	36.109	47.565	40.342
5	35.122	50.062	40.07
6	34.088	53.054	38.986
7	34.029	56.644	39.013
8	33.184	58.154	37.529
-1	43.546	41.769	41.483
-2	45.458	41.559	41.598
-3	48.136	40.816	42.103
-4	48.563	39.964	41.937
-5	51.193	39.73	1 42.578
-6	52.523	38.92	42.989
-7	52.402	39.247	42.777
-8	52.595	39.142	43.585

Tab. 17. Changes occurred to Max dose of Mandible with different shifts

	Mandible	70 Gy	
Shift	Dose X	Dose Y	Dose Z
1	70.443	71.084	71.076
2	69.827	70.557	71.256
3	71.264	68.992	70.351
4	70.715	72.218	70.024
5	70.811	71.352	72.473
6	72.82	70.321	70.941
7	73.1	69.697	71.085
8	74.055	70.91	70.962
-1	70.052	69.865	71.08
-2	69.616	69.02	69.672
-3	69.577	69.68	70.86
-4	69.991	71.36	69.675
-5	68.743	68.404	68.571
-6	69.352	69.143	68.556
-7	69.136	69.026	68.994
-8	69.535	66.973	66.8

Tab. 18. Changes occurred to Max dose of Lt.Temp.with different shifts

	Lt Temp	59.3 Gy	
Shift	Dose X	Dose Y	Dose Z
1	59.884	59.89	59.775
2	62.287	60.876	58.143
3	61.268	62.334	58.515
4	61.925	63.638	57.838
5	62.071	63.576	55.5
6	63.143	64.044	55.996
7	62.941	62.357	55.885
8	63.252	64.011	52.58
-1	61.129	59.446	60.117
-2	58.444	58.887	60.29
-3	58.355	57.707	61.783
-4	56.259	55.826	62.22
-5	55.878	57.763	63.274
-6	55.569	56.698	64.911
-7	54.96	52.997	63.539
-8	53.756	52.942	62.672

Tab. 19. Changes occurred to Max dose of RT. Temp with different shifts

	Rt Temp	59 Gy	
Shift	Dose X	Dose Y	Dose Z
1	61.96	60.265	60.188
2	60.457	61.111	61.303
3	57.958	61.5	59.114
4	57.342	63.218	59.889
5	56.753	64.083	58.195
6	55.213	64.35	58.163
7	54.224	64.6	58.023
8	52.399	66.342	58.917
-1	60.538	62.228	61.112
-2	64.064	59.324	61.718
-3	61.688	58.93	161.32
-4	62.364	57.562	63
-5	61.708	58.362	62.543
-6	63.547	56.536	61.952
-7	63.148	56	63.457
-8	64.203	55.122	62.953

Tab. 20. Changes occurred to Max dose of Lt .Eye with different shifts

	LT Eye	48 Gy	
Shift	Dose X	Dose Y	Dose Z
1	49.33	51.196	51.49
2	51.012	53.328	49.833
3	50.488	53.358	50.568
4	51.101	56.145	54.947
5	51.156	54.779	54.195
6	51.208	58.32	54.625
7	51.902	55.738	53.512
8	51.372	58.4	53.129
-1	48.008	47.025	47.557
-2	45.831	45.382	45.913
-3	45.301	43.542	44.929
-4	44.558	39.304	44.682
-5	43.405	38.584	43.116
-6	41.14	35.227	42.48
-7	40.781	35.129	42.147
-8	39.221	31.59	41.096

Tab. 21. Changes occurred to Max dose of RT Eye with different shifts

	Rt Eye	27.5Gy	
Shift	Dose X	Dose Y	Dose Z
1	25.553	31.444	27.816
2	26.012	36.865	29.768
3	25.243	38.46	29.717
4	22.954	41.132	32.998
5	22.185	43.974	31.796
6	20.905	45.087	32.18
7	21.506	47.015	32.162
8	21.449	48.588	32.305
-1	28.709	25.323	26.597
-2	29.107	23.302	25.778
-3	29.442	20.852	25.273
-4	30.66	15.872	24.12
-5	31.475	13.664	23.3
-6	32.046	11.502	23.78
-7	31.66	1 11.274	22.595
-8	31.59	1 8.945	22.378

Tab. 22. Changes occurred to Max dose of RT Eye with different shifts

LT Optic Nerve		38Gy	
Shift	Dose X	Dose Y	Dose Z
1	38.468	41.899	36.95
2	37.23	147.345	36.9
3	38.402	51.182	36.227
4	37.475	52.393	35.699
5	37.718	54.413	35.957
6	39.357	56.603	36.105
7	38.668	59.258	35.199
8	37.889	61.62	36.89
-1	38.556	33.776	38.469
-2	36.54	30.619	37.84
-3	36.926	27.664	39.98
-4	37.367	21.323	40.335
-5	37.417	19.764	38.332
-6	36.475	15.88	38.513
-7	36.209	14.186	39.578
-8	36.508	12.258	40.4

Tab. 23. Changes occurred to Max dose of RT Optic Nerve with different shifts

Rt Optic Nerv		32 Gy	
Shift	Dose X	Dose Y	Dose Z
1	31.097	38.036	32.299
2	31.79	47.338	31.642
3	31.375	48.664	34.853
4	30.142	52.028	32.954
5	30.272	53.753	34.312
6	30.44	54.946	32.85
7	31.056	57.88	33.088
8	29.345	59.509	32.58
-1	32.819	27.319	33.15
-2	34.553	26.87	33.916
-3	33.372	21.68	31.938
-4	33.113	18.287	32.003
-5	34.682	16.846	31.186
-6	33.818	15.278	31.379
-7	34.136	14.09	132.217
-8	35.408	13.272	31.622

Tab. 24. Changes occurred to Max dose of LT TMJ with different shifts

	LTTMJ	69 Gy	
Shift	Dose X	Dose Y	Dose Z
1	69.087	72.423	68.638
2	69.299	68.692	69.984
3	69.234	71.458	72.068
4	70.151	69.666	68.022
5	70.289	70.161	67.092
6	71.586	70.679	70.456
7	73.394	72.707	68.928
8	71.934	71.162	67.834
-1	69.739	67.478	68.159
-2	66.332	66.968	67.805
-3	68.364	66.321	68.791
-4	68.062	62.82	68.011
-5	65.243	60.664	67.895
-6	64.393	57.36	68.57
-7	62.148	55.866	66.769
-8	59.736	52.004	66.901

Tab. 25. Changes occurred to Max dose of RT TMJ with different shifts

	RTTMJ	65 Gy	
Shift	Dose X	Dose Y	Dose Z
1	64.223	67.173	63.641
2	63.891	66.94	66.618
3	59.44	66.8	63.005
4	58.77	72.07	64.119
5	58.107	69.614	62.941
6	52.846	71.024	63.547
7	50.865	70.904	62.062
8	47.48	69.608	62.014
-1	66.388	65.361	66.138
-2	70.02	63.395	64.624
-3	67.289	61.542	65.01
-4	68.788	59.19	64.654
-5	68.401	55.572	66.617
-6	70.995	51.764	63.441
-7	68.994	50.018	63.364
-8	69.814	48.455	62.909

Tab. 26. Changes occurred to Mean dose of Thyroid gland with different shifts

Thyroid Glani 43.5Gy		43.5Gy	
Shift	Dose X	Dose Y	Dose Z
1	45.523	45.633	44.615
2	45.886	45.902	45.885
3	46.07	46.255	46.237
4	46.211	46.841	46.608
5	46.259	47.27	46.756
6	46.281	47.504	46.95
7	46.232	47.801	47.115
8	46.203	48.52	47.348
-1	45.004	45.061	46.881
-2	44.649	44.791	44.47
-3	44.169	44.347	44.082
-4	43.808	44.25	43.453
-5	43.152	44.195	43.22
-6	42.621	44.101	42.71
-7	42.273	43.926	42.385
-8	41.995	43.667	41.944

Tab. 27. Changes occurred to Mean dose of Esophageal inlet with different shifts

	Esophageal Inlet	42 Gy	Mean
Shift	Dose X	Dose Y	Dose Z
1	40.919	42.328	42.012
2	40.381	42.024	41.604
3	39.498	42.523	41.455
4	38.964	42.604	41.649
5	38.453	43.449	41.114
6	37.454	43.509	41.262
7	37.467	43.263	40.571
8	37.048	44.197	40.824
-1	43.26	42.159	41.88
-2	44.107	41.567	42.026
-3	44.783	40.504	42.153
-4	46.28	40.821	41.451
-5	47.193	40.57	41.333
-6	48.138	40.406	41.225
-7	48.965	40.224	41.031
-8	50.518	39.373	40.536

Tab. 28. Changes occurred to Mean dose of Cervical Esophagus with different shifts

Shift	Cervical Esophagus Dose X	39.22Gy Dose Y	Mean Dose Z
1	38.67	38.925	38.897
2	38.196	38.3	38.653
3	37.779	37.9	1 38.554
4	37.313	37.772	38.164
5	37.043	37.386	37.768
6	36.745	36.882	37.634
7	36.375	36.088	37.322
8	36.292	35.703	37.155
-1	39.837	39.733	39.517
-2	40.485	39.715	39.884
-3	40.907	39.833	40.049
-4	41.265	40.319	40.192
-5	41.997	40.474	40.268
-6	42.375	40.717	40.605
-7	42.88	140.653	41.026
-8	43.473	40.724	41.162

Tab. 29. Changes occurred to Mean dose of Base of tongue with different shifts

Shift	Base Of Tongue Dose X	45Gy Dose Y	Dose Z
1	45.492	45.376	45.6
2	45.506	59.502	45.732
3	45.568	45.453	46.032
4	45.876	45.643	46.227
5	46.294	45.54	46.493
6	46.447	45.488	46.708
7	46.825	45.432	47.118
8	41.385	45.25	147.426
-1	45.256	45.162	45.223
-2	45.529	44.724	44.86
-3	45.716	44.694	44.579
-4	45.822	44.643	44.534
-5	46.36	44.376	44.256
-6	46.453	44.376	44.298
-7	47.035	44.293	44.284
-8	47.605	44.345	44.322

Tab. 30. Changes occurred to Mean dose of Lt Carotid with different shifts

Shift	LT Carotid Dose X	60.5Gy Dose Y	Dose Z
1	60.431	60.334	60.202
2	60.307	59.746	59.739
3	60.243	59.323	59.515
4	60.149	59.255	59.41
5	59.736	58.885	58.999
6	59.338	58.601	58.471
7	59.037	58.111	57.999
8	58.399	57.901	57.508
-1	60.461	60.709	60.725
-2	60.31	60.837	60.674
-3	60.078	61.142	60.583
-4	59.968	61.704	60.59
-5	59.761	61.826	60.783
-6	59.598	62.244	60.974
-7	59.039	62.124	60.757
-8	58.959	62.274	60.833

Tab. 31. Changes occurred to Mean dose of Rt Carotid with different shifts

Shift	RT Carotid Dose X	64.3Gy Dose Y	Dose Z
1	65.155	64.474	64.573
2	65.155	64.513	64.534
3	65.155	64.479	64.57
4	65.155	64.394	64.484
5	65.155	64.298	64.233
6	65.155	64.199	63.886
7	65.155	64.066	63.4
8	65.155	63.822	62.97
-1	64.317	64.634	64.496
-2	63.93	164.597	64.294
-3	63.506	64.464	64.047
-4	63.183	64.748	64.04
-5	62.653	64.544	63.876
-6	61.903	64.605	63.752
-7	61.269	64.34	63.386
-8	60.634	64.379	63.277

DISCUSSION

Several studies have investigated setup uncertainty in H&N cancer patients [8]. According to the International Commission on Radiation Units and Measurements report 62 [5], an inappropriate definition of the CTV-PTV margin, accounting for organ motion and setup uncertainties, may yield an under-dose to the CTV. Organ motion could be neglected, while variability due to inadequate setup or deformity must be carefully considered. In clinical practice, use of daily IGRT is not always possible because of limited facilities in some countries as well as concerns about increased daily doses to patients [4]. Because of RT treatment for H and N cancer, anatomical modifications due to tumor regression led to geometric change of tumor volume and organs at risk and Margins in the three translation directions should be done.

Generally, our study record shifts during all fractions (shown in Tables 1-33).

This study recommends on-line IGRT for patients receiving RT to deliver more accurate dose to tumor and avoid extra dose to organs at risk due to anatomical change also according to (11-12) shifts in all direction reduced when using on line image guided leading to reduce margins in all direction surrounding the tumor and saving critical organs.

The primary objective of the study was to measure inter-fraction setup variation in head and neck cancer patients undergoing. Displacements of portal images from CT images, set as reference images, were measured for calculating errors are related to any accidental error during setup, due to mis-positioning of the patient in the mask, movements of the patient or organ motion in the period between positioning and start of irradiation or during irradiation. Naiyanet, N. et al [10] reported the L-R, S-I and A-P axes. While our study has shown the errors along the L-R, S-I and A-P axes) that 0.05 mm, 0.08 mm and -0.02 mm. Large systematic errors lead to a large under-dosage.

The secondary objective of the present study was to define adequate CTV-to-PTV margin for IMRT of head and neck cancer in our department. Ideally, the CTV-to-PTV

Tab. 32. Illustrate Changes occurred in critical organs according to shifts

	Lt lens	Rt lens	Optic Chiasm	B.S.	S.C.	Lt parotid	RT parotid	Lt cochlea	Rt cochlea	Mandibe	Lt Temp	Rt temp
X +direction	↑	Const.	↑	↑	↑	↑	↓	↑	↓	variated	↑	↓
X -direction	↓	variated	↓	↑	↑	↓	↑	variated	↑	variated	↓	↑
Y +direction	↑	↑	↑	↑	variated	↑	↑	↑	↑	variated	↑	↑
Y -direction	↓	↓	↓	↓	variated	↓	↓	variated	↓	variated	↓	↓
Z +direction	↑	variated	↓	↓	↓	↑	↑	↓	↓	variated	↓	↓
Z -direction	variated	variated	↑	↑	↑	const	↓	↑	↑	↓	↑	↑

Tab. 33. Illustrate changes occurred in critical organs according to shifts

	Lt eye	Rt eye	Lt O.N	Rt O.N.	Lt TMJ	Rt TMJ	Thyroid	Eso. inlet	Cervical Eso.	Base of tongue	Lt carotid	Rt carotid
X +direction	↑	↓	variated	↓	variated	↓	↑	↓	↓	↑	↓	Almost const.
X -direction	↓	↑	↓	↑	↓	↑	↓	↑	↑	↑	↓	↓
Y +direction	↑	↑	↑	↑	variated	variated	↑	↑	↓	Almost const.	↓	Almost const.
Y -direction	↓	↓	↓	↓	↓	↓	↓	↓	↑	↓	↑	Almost const.
Z +direction	↓	↑	variated	variated	variated	variated	↑	↓	↓	↑	↓	↓
Z -direction	↑	↓	↑	variated	variated	variated	↓	↓	↑	↓	Almost const.	↓

margin should be determined solely by the magnitudes of the uncertainties involved. In practice, the clinician usually also considers abutting healthy tissues when deciding on the size of the CTV-to-PTV margin.

Generally, our study record shifts during all fractions (shown in Tables 1) & then illustrated the differences occurred in target and critical organs according to shifts that applied to plan on planning system. We found that all targets dose reduced with increasing shifts.

CONCLUSION

In this examine, the scientific effectiveness of planned and delivered dose distributions of IMRT technique for head-and-neck cancer became evaluated the usage of both physical and dose constraints criteria. The distinction between the "one-to-all" and "cascade" dose distributions became small, statistically insignificant, and really near the values of the corresponding treatment plans. However, for a fraction of the sufferers and given OAR, the differences among the added and deliberate doses had been mainly large. These findings aid the necessity of the correct affected person setup earlier than the treatment the usage of IGRT, as a result minimizing dose inaccuracy mistakes. We recommend reducing setup errors in patients with Head and Neck cancer receiving RT, the use of on-line image-guided radiotherapy is recommended to increase accuracy.

LIST OF ABBREVIATIONS

Abbreviation	Symbol
Three Dimensional Radiation Therapy	3D CRT
Intensity Modulated Radiation Therapy	IMRT
Dynamic Multi Leaf Collimator	DMLC
Static Multi Leaf Collimator	SMLC
Dose Volume Histogram	DVH
Mega Volt	MV
Clinical Target Volume	CTV
Planning Target Volume	PTV
Organ at Risk	OAR
Gray	Gy
Fraction	Fr
Computed Tomography	CT
Treatment Planning System	TPS
Linear Accelerators	LINAC
Electronic Portal Imager Device	EPID
Digitally Reconstructed Radiograph	DRR
Prostate-Specific Antigen	PSA
Beam Eye View	BEV
Right	Rt
Left	Lt
Monitor Unit	MU
Clock Wise	CW
Counter Clock Wise	CCW
Dose Maximum	D_{max}

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