CBCT image guidance in Head and Neck irradiation - the impact of daily and weekly imaging protocols

Wajid Ali, MBA RRT[1]; Sohail Ahmed, MBA RRT[2]; Syed Asher Amjid, RRT MBA[1,2]
[1]Dow University of Health & Sciences Department of Comprehensive cancer care Centre (DUHS) Radiation Oncology

Abstract

This study evaluated the impact of a daily and weekly image guided radiotherapy

(IGRT) protocols in reducing setup errors and setting of appropriate margins in head and neck

cancer patients

Interfraction and systematic shifts for the hypothetical day 1-3 plus

weekly imaging were extrapolated from daily imaging data from 32 patients (970CBCT scans).

In addition, residual set-up errors (RSE) were calculated by taking the average shifts in each

direction for each patient based on the first three shifts and were presumed to represent

systematic setup error. The CTV to PTV margins were calculated using van-Herk formula and

analysed for each protocol.

Introduction

Radiation therapy remains a vital modality in the management of head and neck cancer patients. However, there are numerous factors that can affect the accuracy of radiotherapy treatment delivery. Several studies have reported random or interfraction set-up errors in head and neck cancer treatment and some have analysed the effects various set-up margins used during planning

Methods and Materials

Interfraction and systematic shifts for the hypothetical day 1-3 plus weekly imaging were extrapolated from daily imaging data from 31 patients (964 CBCT scans). In addition, residual set-up errors (RSE) were calculated by taking the average shifts in each direction for each patient based on the first three shifts and were presumed to represent systematic setup error. The CTV to PTV margins were calculated using van-Herk formula and analysed for each protocol.

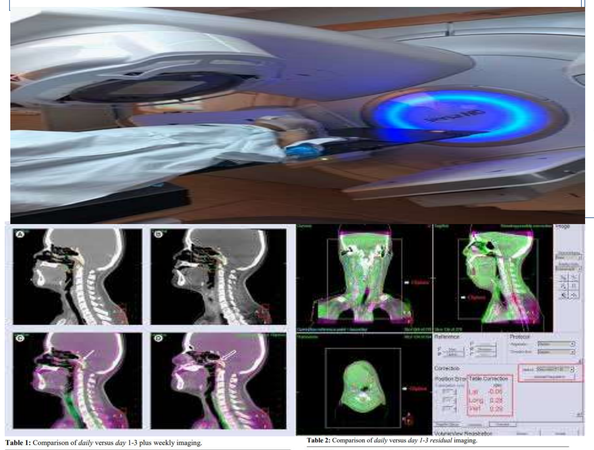


Table 1: Comparison of *daily* versus *day* 1-3 plus weekly imaging.

Direction	Shifts and Magnitude (mm)		
	Daily (mm)	Day 1-3 plus weekly (mm)	*p*-value
S-I	0.4	1.9	0.07
L-R	-1.6	1.8	0.31
A-P	0.4	2.1	0.28

Abbreviations: S-I; superior-inferior, L-R; left-right, A-P; anterior-posterior

Table 2: Comparison of *daily* versus *day 1-3 residual* imaging.

Direction	Shifts and Magnitude (mm)		
	Daily (mm)	Day 1-3 plus weekly (mm)	*p*-value
S-I	0.4	2.5	0.54
L-R	-1.6	2.1	0.11
A-P	0.4	2.7	0.72

Abbreviations: S-I; superior-inferior, L-R; left-right, A-P; anterior-posterior

Table 3: CTV-PTV Expansions -*daily* imaging protocol.

Variables	Shifts and Magnitude (mm)		
	S-I	L-R	A-P
Systematic Shifts	0.4	-1.6	0.4
Random Shifts	0.8	0.3	0.5
CTV-PTV expansion	1.6	3.8	1.4

Abbreviations; CTV; clinical target volume, PTV; planning target volume

Table 4: CTV-PTV Expansions -*day 1-3 plus weekly* protocol.

Variables	Shifts and Magnitude (mm)		
	S-I	L-R	A-P
Systematic Shifts	1.9	1.8	1.5
Random Shifts	0.7	0.7	0.6
CTV-PTV expansion	5.2	5.0	4.2

Abbreviations: CTV; clinical target volume, PTV; planning target volume

Target and Organ at Risk Definition

The radiation oncologist outlined the gross target volumes (GTV1) which encompassed the primary tumor and involved lymph nodes. A 5mm margin was used for expansion to the clinical target volume (CTV1). A second clinical target volume (CTV2) included all electively treated lymph nodes. The CTVs were expanded in all directions by a margin of 0.5cm to form the planning target volume (PTV1) and PTV2. The organs at risk (OARs) delineated include bilateral lens, spinal cord (SC), brainstem (BS), optic nerves(ON), optic chiasm (OC), bilateral parotid glands (PG) and the oral cavity(OC) as per departmental protocol. A planning organ at risk volume (PRV) was contoured for the spinal cord (SC) by adding a 0.5cm margin and 0.3cm for the optic chiasm and the optic nerves. The prescription dose was 70 Gy to PTV1, whereas the PTV2 was treated to 56-63Gy.

Fig: 1 (a) Daily versus day1-3 residual shifts in the S-I direction (n=31).

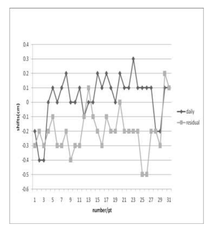


Fig 1(b) Daily versus day 1-3 residual shifts in the L-R direction (n=31).

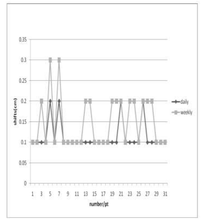


Fig 1 (c) Daily versus day 1-3 residual shifts in the A-P direction (n=31).

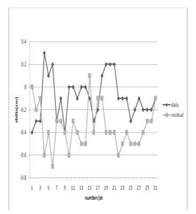


Fig 2(a) Mean shifts for daily versus day 1-3 plus weekly S-I direction (n=31)

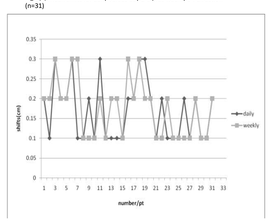
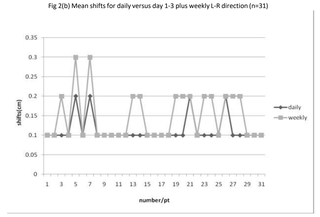


Fig 2(b) Mean shifts for daily versus day 1-3 plus weekly L-R direction (n=31)



Results

The mean interfraction shifts for daily imaging were 0.8mm, 0.3mm and 0.5 mm in the S-I (Sup-Inf), L-R (Left-Right) and A-P (Ant-Post) direction, respectively. On the other hand the mean shifts for day 1-3 plus weekly imaging were 0.9mm, 1.8mm, and 0.5 mm in the S-I, L-R and A-P direction, respectively. The mean day 1-3 residual shifts were 1.5mm, 2.1mm and 0.7mm in the S-I, L-R and A-P direction respectively. No significant difference was found in the mean setup error for the daily and hypothetical day 1-3 plus weekly protocol. However, the calculated CTV to PTV margins for the daily inter-faction imaging data were 1.6mm, 3.8mm and 1.4mm in the S-I, L-R and A-P directions, respectively. Hypothetical day 1-3 plus weekly resulted in CTV-PTV margins of 5mm, 4.2mm and 5mm in the S-I, L-R and A-P direction

Conclusions

Finding the most suitable imaging protocol for head and neck cancers is still a controversial issue. Some authors have reported results which support the use of daily imaging (4, 8, 11, 20, and 25) whereas other studies were not in favour of daily imaging (15-18). Some researchers reported average doses per scan for head and neck imaging of 0.07cGy and 0.03 cGy, therefore reduction in imaging frequency would be preferable (24, 26). However, the results of this study show that a daily CBCT protocol reduces setup errors and allows setup margin reduction in head and neck radiotherapy compared to a weekly imaging protocol. In addition to the increased dose to the patient, the impact of daily imaging on workflow and availability of resources could be factors in considering whether a daily imaging protocols could be implemented

Contact

<Wajid Ali Channa>
<Dow University of Health Sciences >
Email:wajid.channa@duhs.edu.pk
Website:www.duhs.edu.pk