

# **Investigation of Intrafraction Motion During Spine Stereotactic Radiosurgery**

- \* Stereotactic body radiation therapy (SBRT) is a novel radiation technique that delivers a high dose of radiation to the tumor with great precision, by taking advantage of recent advances in real-time tumor tracking and radiation dose delivery systems.
- \* Metastasis to the spine occurs in up to 70% of all cancer patients, and 10 to 20 % of cancer patients with bony spinal metastasis will develop symptomatic spinal cord compression.

# Purpose

- \* In stereotactic radiosurgery (SRS) high dose is given to the target in a single fraction. Therefore this treatment technique leads to long treatment time.
- \* It is crucial for a patient not to move during the treatment. When critical organs are very close to target like in spine metastasis cases, the immobilisation of patients becomes more important.
- \* The aim of this study is to compare cone beam computed tomography (CBCT) images that were acquired before and just after the treatments and to determine if any intrafraction motion occurred.

# Method

- \* Ten patients who were treated with stereotactic radiosurgery for spine metastasis were included in this study.
- \* Patients were immobilized in supine position by using vacuum preformed bed.
- \* Patients were scanned with 1 mm slice thickness in CT.

## Average volumes and volume ranges of PTV and OAR

Structure	Mean Volume (cm <sup>3</sup> ) ± S.D	Volume Range (cm <sup>3</sup> )
PTV	36.31 ± 13.48	68.19 - 23.15
Partial Spinal Cord	6.93 ± 1.83	4.02 - 9.24

- \*VMAT plans with two full arc were generated using the Eclipse 10.1 treatment planning system with AAA calculation algorithm.
- \*6 MV photons from Varian Trilogy machine was used for treatment.

- \* RTOG 0631 recommendations were applied for treatment planning.
- \* The protocol stipulated that the CTV and not less than 90% of the PTV should receive at least the prescribed dose, i.e. 16 Gy.

# RTOG 0631 guidelines for PTV and OARs

Structure	Dose Constraints
PTV	$V_{16\text{Gy}} \geq 90\%$
Spinal Cord	$V_{10\text{Gy}} \leq 0.35 \text{ cc}$
	$V_{14\text{Gy}} \leq 0.03 \text{ cc}$
Partial Spinal Cord	$V_{10\text{Gy}} \leq 10\%$

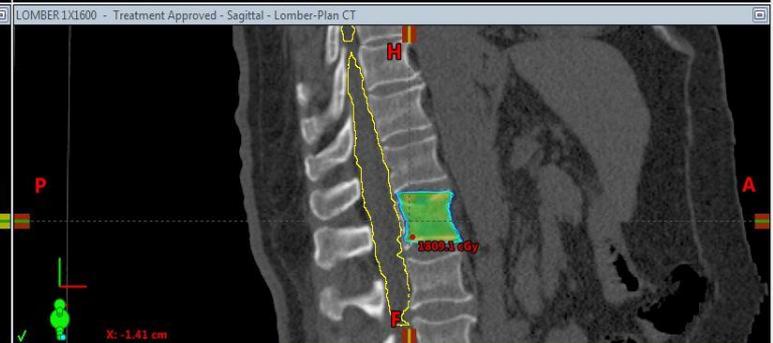
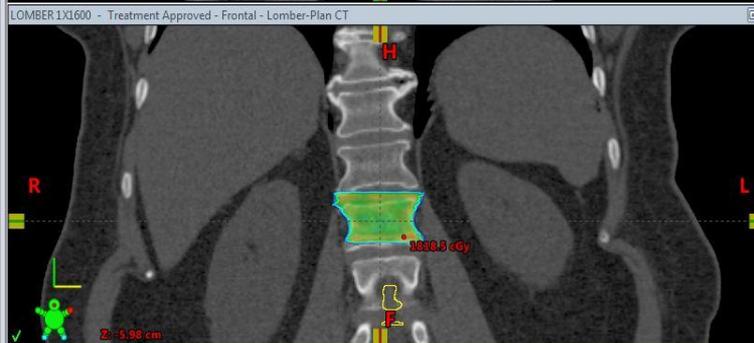
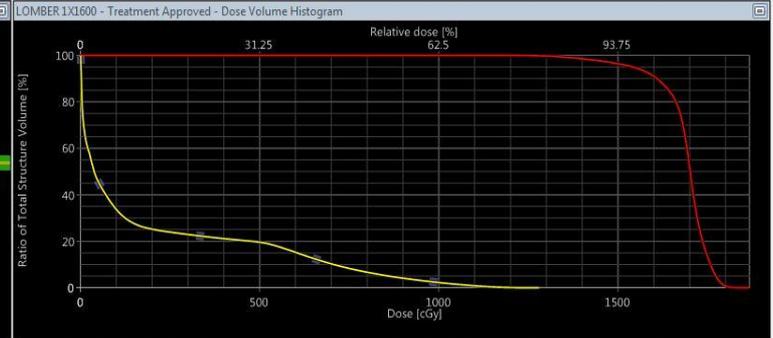
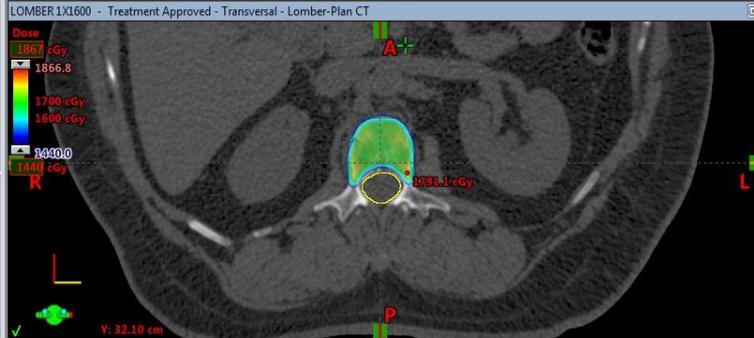


Selection Contouring Registration External Beam Planning Brachytherapy Planning Brachytherapy 2D Entry Plan Evaluation

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- 5677
  - Lomber-Plan CT
    - Lomber-Plan CT
      - Series 38
        - CBCT\_1
    - C1
      - LOMBER 1X1600

- R kidney
- R lung
- shell h
- shell h 2
- SHELL1
- SHELL2
- SHELL3
- spinal
- User Origin
- Reference Points
  - PTV\*
- Dose
  - Fields
- Fields
  - Field 1
    - Field 1-DRR (Live)
    - MLC
  - Field 2
    - Field 2-DRR (Live)
    - MLC
  - AP
    - AP-DRR (Live)
  - LAT
    - LAT-DRR (Live)
  - CBCT
    - CBCT-DRR (Live)



Fields	Dose Prescription	Field Alignments	Plan Objectives	Optimization Objectives	Dose Statistics	Calculation Models	Plan Sum					
View	DVH Line	Structure	Approval Status	Plan	Course	Volume [cm <sup>3</sup> ]	Dose Cover.[%]	Sampling Cover.[%]	Min Dose [cGy]	Max Dose [cGy]	Mean Dose [cGy]	
<input type="checkbox"/>		oesophagus	Approved	LOMBER 1X1600	C1							
<input type="checkbox"/>		L kidney	Approved	LOMBER 1X1600	C1	199.8	100.0	99.7	9.8	683.3	164.0	
<input type="checkbox"/>		heart	Approved	LOMBER 1X1600	C1							
<input type="checkbox"/>		Bowel	Approved	LOMBER 1X1600	C1							
<input checked="" type="checkbox"/>		spinal	Approved	LOMBER 1X1600	C1	38.4	100.0	99.4	0.6	1280.4	193.4	
<input type="checkbox"/>		PTV*	Approved	LOMBER 1X1600	C1							
<input type="checkbox"/>		SHELL1	Approved	LOMBER 1X1600	C1							
<input type="checkbox"/>		SHELL2	Approved	LOMBER 1X1600	C1							

- \* Translational and rotational initial setup errors were initially corrected based on bone anatomy matching DRR images with AP and LAT kV images.
- \* CBCT images (pre - CBCT) were acquired.
- \* If required, additional setup up errors were corrected by couch shift.

- \* Immediately after treatment completion, second CBCT (post CBCT) was acquired.
- \* The pre and post treatment CBCT of ten patients were analyzed for evaluation of intrafractional motion.

Transversal - Lomber-Plan CT - CBCT\_1 - 12/10/2013 12:45 PM

Isocenter: Treatment (Field: Field 1 - 12/10/2013 12:50:04 PM)



Sagittal - Lomber-Plan CT - CBCT\_1 - 12/10/2013 12:45 PM



Frontal - Lomber-Plan CT - CBCT\_1 - 12/10/2013 12:45 PM



# Results

- \*The monitor unit values of ten patients for 2 full arc treatment planning technique were shown in table.
- \*Average MU value was 6150.9.

## MU values for 2 arc VMAT treatment plans

	MU
Patient 1	6054
Patient 2	6736
Patient 3	6214
Patient 4	6334
Patient 5	6812
Patient 6	5190
Patient 7	5856
Patient 8	6459
Patient 9	6214
Patient 10	5640

- \*The intrafraction variation between pre CBCT and post CBCT in vertical, longitudinal and lateral directions were given in table.
- \*The differences were smaller than 2 mm in all directions.
- \*Intrafraction variation were frequently seen in lateral direction.
- \*The relationship was found between treatment time and intrafraction variation.

## The vertical, lateral and longitudinal shifts between pre CBCT and post CBCT

	Vertical Shift	Longitudinal Shift	Lateral Shift
Patient 1	0	0	0.09
Patient 2	0.03	0.04	0.14
Patient 3	0.01	0.01	0.10
Patient 4	0.02	0.01	0.12
Patient 5	0.05	0.06	0.15
Patient 6	0	0	0.05
Patient 7	0	0	0.08
Patient 8	0.02	0.02	0.13
Patient 9	0.01	0	0.10
Patient 10	0	0	0.08

# Conclusion

Although treatment time is very long for spine stereotactic surgery treatment no significant intrafraction variation were seen during the treatment.

# THANK YOU...

