JULY 12–16 2020 VIRTUAL JOINT AAPM | COMP MEETING
EASTERN TIME [GMT-4]

Feasibility study to use HDR interstitial brachytherapy for the treatment of small skin cancer at nose

Z. Gu, MS, J.R. Robbins, MD, and Y. Kim, PhD
Department of Radiation Oncology, The University of Arizona

THE UNIVERSITY OF ARIZONA COLLEGE OF MEDICINE
Banner University Medicine

INTRODUCTION

The incidence of skin cancer is very common, with a recent estimate of over 3 million people in the US a year [1]. These tumors are usually rare to metastasize, but can be locally destructive, resulting in serious cosmetic defects and reduced life quality [2].

Surgery is the mostly used option because of the short overall treatment time and good local control rates. However, due to the tumor size and location and concerns about cosmetic outcome, surgery sometimes may not be a feasible choice. In recent years, radiotherapy becomes more common to treat surface skin cancer.

External beam radiotherapy always requires a margin to the malignancy for motion and setup errors, thus irradiating a large volume of tissue in order to obtain a good coverage and increasing the toxicity of neighboring OARs.

In contrast, high-dose rate (HDR) brachytherapy directly introduces radioactive material to the tumor area temporarily. The radioactive source moves with target so it does not require PTV margin for uncertainty. Dose escalation to tumor can be achieved with much less dose to adjacent normal structures.

AIM

For small skin cancer at the nose (≤ 2 cm), electron beam has been commonly used. Because of high uncertainty in dose calculation and setup for electron beam therapy, large lateral PTV margin is required.

In this study, a new approach using HDR interstitial brachytherapy with 3D-printed bolus is proposed as a simple but more accurate method. Its dosimetry data were compared to those of electron beam approach.

METHOD

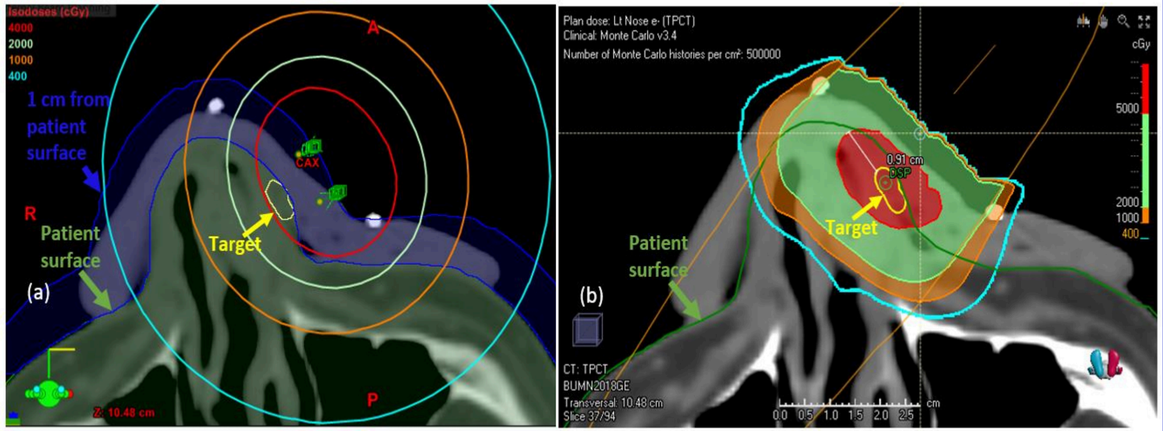
- For 6 electron plans, Ir-192 HDR plans based on CT images were retrospectively generated using 2 or 3 catheters 1 cm apart and 1 cm away from the skin surface.
- Two dose fractionations were used in electron plans: 55 Gy in 22 fractions, 50 Gy in 15 fractions. 40 Gy in 10 fractions were used in the HDR plans.
- Plan comparison was performed between electron and HDR plans. (For 2 clinical electron plans, hand-made customized bolus was modified after planning CT scan and no electron plan was available.)
- For two of patients, eyes and lenses were defined as OARs.
- Customized bolus using 3D-printing is under development.

RESULTS

- For HDR interstitial brachytherapy plans, average target size was 7.6 mm (ranging from 5.4 to 9 mm) in cranio-caudal dimension, 3.6 mm (from 2.2 to 5 mm) in anterior-posterior dimension, and 11.8 mm (from 7 to 20 mm) in lateral dimension. 40Gy in 10 fractions were prescribed.
- For electron plans, lateral PTV margin (1-2 cm) was added and 2 dose fractionations were used: 55 Gy in 22 fractions, 50 Gy in 15 fractions.
- The average target coverage (V100) was 97.01% (from 96.30% to 97.45%) in HDR plan.
- The average high dose in the target (D0.03cc) was higher with HDR plans: 137.41% (from 129.07% to 153.51%) vs. 114.34% (from 109.72% to 119.00%) with electron plans.
- The volume enclosed by the prescription dose was much less with HDR plans (0.6 cc vs. 2.67 cc).
- OAR doses were higher with HDR plans (3.2 Gy vs.0.82 Gy for lenses D2).

	Target size			Target		Volume receiving Rx dose (cc)	Right eye		Right lens		Left eye		Left lens	
	Cranio-caudal (mm)	AP (mm)	Lat (mm)	V100	D0.03cc		Mean dose (cGy)	D2 (cGy)	Mean dose (cGy)	D2 (cGy)	Mean dose (cGy)	D2 (cGy)	Mean dose (cGy)	D2 (cGy)
Electron														
Patient 1				100.00%	109.72%	2.28	63	267	101	155	37	103	62	99
Patient 2				100.00%	112.00%	2.55	13	15	14	16	27	52	40	57
Patient 3				100.00%	119.00%	2.42								
Patient 4				92.40%	116.65%	3.42								
Average				98.10%	114.34%	2.67	38	141	57.5	85.5	32	77.5	51	78
HDR														
Patient 1	5.4	4.0	7.0	97.39%	131.54%	0.43	254	389	321	353	189	269	225	254
Patient 2	7.8	3.2	8.9	96.30%	153.51%	0.71	151	197	164	179	345	497	430	495
Patient 3	8.0	2.2	11.2	97.45%	129.07%	0.34								
Patient 4	9.0	5.0	20	96.90%	135.50%	0.9								
Average	7.6	3.6	11.8	97.01%	137.41%	0.60	202.50	293.00	242.50	266.00	267.00	383.00	327.50	374.50

Comparison of dosimetric parameters between electron plans and HDR brachytherapy plans.



Comparison of dose distribution between HDR plan and electron plan

(a) (prescription dose of 40Gy) HDR plan *(b) (prescription dose of 50Gy) electron plan*

CONCLUSIONS

For a small skin cancer at nose, HDR interstitial brachytherapy approach is feasible by irradiating less volume with less uncertainty compared to conventional electron beams.

Our proposed simple approach using HDR interstitial brachytherapy (using 2 or 3 catheters) with 3D-printed customized bolus which is under development would be more accurate and simpler than the conventional electron beam for the treatment of small (< 2 cm) skin cancer at the nose.

REFERENCES

[1] Rogers HW, Weinstock MA, Feldman SR, Coldiron BM. Incidence estimate of nonmelanoma skin cancer (keratinocyte carcinomas) in the US population. JAMA Dermatol. Published online April 30, 2015.

[2] Treatment of skin carcinomas of the face by high-dose-rate brachytherapy and custom-made surface molds. Guix B, Finestres F, Tello J-I, Palma C, Martinez A, Guix JR, Guix R. Int J Radiat Oncol Biol Phys. 2000;47:95–102.

CONTACT INFORMATION

zhenggu@arizona.edu jrobbins@arizona.edu
yongbokkim@arizona.edu