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Application of U-fixed red wax mask in radiotherapy

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Abstract ***Objective:*** The aim of our study was to compared non-red wax compensator and adding red wax compensator in the treatment plans of the minimum dose, maximum dose, mean dose and target surface dose, and compare the dose volume histograms (DVH) parameters and isodose distributions of two plans. ***Methods:*** From January 2009 to December 2010, 8 patients with superficial head and neck cancer and without surgery treatment were collected. They all confirmed by cancer center, Tianmen First People's Hospital. Topslane WiMRT was used to design the treatment plan of non-red wax compensator and adding red wax compensator, with 6 MV photons using three-dimensional conformal irradiation mode design, the prescription dose was 50 Gy/25 times. ***Results:*** Compared non-red wax compensator with adding red wax compensator, its target minimum dose (t = –3.157, P < 0.05) and the target surface dose significantly improved (t = –0.020, P < 0.05), while the target maximum dose (t = –0.140, P > 0.05) and mean dose (t = –9.914, P > 0.05) were considered no significant difference. ***Conclusion:*** The use of U-shaped mask fixed red wax film production in conformal radiotherapy tissue compensator can significantly improve the surface dose and dose distribution superficial planning target volume.

Key words head and neck cancer; tissue compensator; radiotherapy; adding red wax compensator

Location of head and neck cancer patients with lesions in superficial often need to add tissue compensator to improve dose distribution in radiotherapy. Currently used tissue compensator included solid water compensator and homemade pigskin compensator. But there is hard to preserve and the fit is poor and can not play a role in dosage compensation issues in clinical applications. This paper describes a currently used in dentistry as a molding material red wax to make radiation therapy tissue compensator.

Materials and methods

Patients

From January 2009 to December 2010, 8 patients with superficial head and neck cancer and without surgery treatment were collected. They all confirmed by Cancer Center, Tianmen First People's Hospital. Among them, 6 were males, 2 were females, the age ranged from 35 to 60 years with a median age of 44 years. The research program approved by the hospital ethics committee, signed informed consent by the patient before treatment.

Materials

Using red wax to make radiation therapy tissue compensator, the main component of paraffin wax, softening temperature of 38–46 ℃, and have a similar physical characteristics with water (Table 1). Red wax can be used as human tissue equivalent material [1], its plastic deformation was greater than 55% at temperatures higher than 43 ℃.

Fixed position and mask production

Conventional methods positioning, straightened position of the laser line. Making conventional U-shaped mask and fixed U-shaped red wax mask: mask fixed head and neck warm water heating, the mask forming [2–3]. This is conventional U-shaped mask. After removal of the mask, according to the thickness of the compensation, a certain number of red wax with about 50 ℃ warm water of the hot red wax were selected. According to tumor location will be red wax slice shape in the face. Local heating the established mask fixed in the patient's head and neck. The mask on the surface and then apply the warm red wax slices, make the red wax slice and thermoplastic film is not easy to fall off. When temperature below 37 ℃, complete fixed with red wax slice of U-shaped mask production.

Target delineation and treatment planning

After the CT location, import the image into the treatment planning system. General outline planning target volume (PTV), skin attention will be drawn into the red

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Table 1 The property of paraffin wax and water

Material	Chemical composition	Density (G/cm^3)	Electrons ($\times 10^{23}$)	Effective atomic number
Water	H_2O	1	3.34	7.42
Paraffin	C_nH_{2n+2}	0.87–0.91	3.44	5.42

Table 2 The planning target volume dose of before and after add red wax compensator (mean ± SD)

Groups	Min dose[a]	Max dose	Average dose	Target surface dose[a]
Non add red wax compensator	2899.23 ± 559.67	5103.03 ± 325.74	4542.51 ± 479.46	2891.88 ± 539.95
Adding red wax compensator	3624.34 ± 381.12[a]	5106.69 ± 366.26	4555.61 ± 437.82	4928.75 ± 150.42[a]

[a] Compared with non-red wax compensator, $P < 0.05$

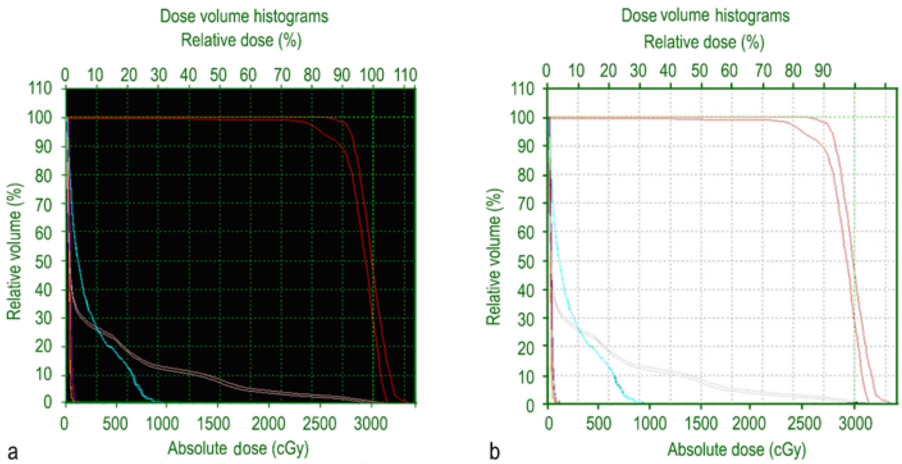

Fig. 1 Compared the compensator plan target DVH and non-compensator plan target DVH. (a) The plan target of add red wax compensator; (b) The plan target of non- red wax compensator

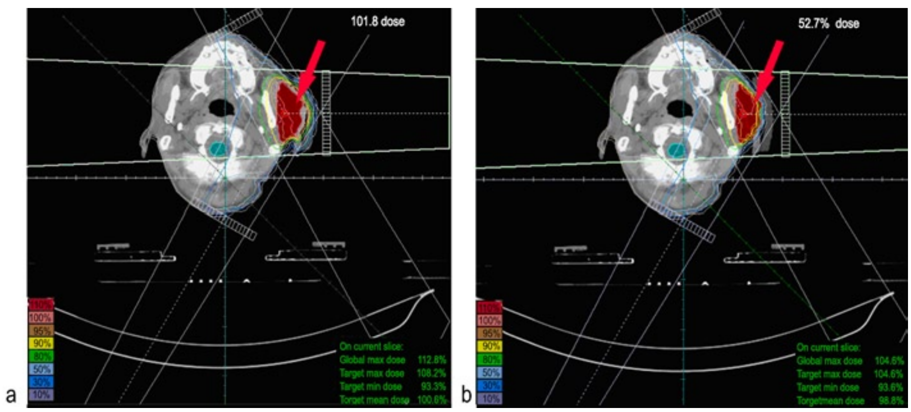

Fig. 2 The plan dose distribution of compare non-red wax compensator and add red wax compensator. (a) Non-red wax compensator; (b) Add red wax compensator

wax when fully outlined. Topslane WiMRT were used to design the treatment plan of non-add red wax compensator and adding red wax compensator, with 6 MV photons using three-dimensional conformal irradiation mode design, the prescription dose was 50 Gy/25 times.

Program evaluation

Compared non-red wax compensator and add red wax compensator in the treatment plans of the minimum dose, maximum dose, mean dose and target surface dose, and compared the two plans dose volume histograms (DVH) parameters and isodose distributions.

Statistical analysis

SPSS 21 statistical software was used to detect the data, and the results were expressed as mean ± SD. The two sets of parameters paired samples t test, $P < 0.05$ was considered as significant difference.

Results

Target dose

Compared non-red wax compensator with add red wax compensator, its target minimum dose (t = –3.157, P <

0.05) and the target surface dose significantly improved (t = –0.020, $P < 0.05$), while the target maximum dose (t = –0.140, $P > 0.05$) and mean dose (t = –9.914, $P > 0.05$) were considered no significant difference (Table 2).

Dose volume histograms and isodose distribution map

Compared DVH and isodose distribution map of the two plans show that the compensation target dose is superior to uncompensated target, the outer surface of the uncompensated target dose was significantly insufficient (Fig. 1), and isodose curve is more ideal. 51.2% of the dose curve in uncompensated plan and 102.7% isodose line of compensator plan volume is quite (Fig. 2).

Discussion

In radiotherapy plan design, an irregular or superficial tumors often require that the human equivalent material repairing dose, so that provide a flat surface or corrected radiation dose to improve the dose of the lesion superficial parts [4–6]. Water is the main component of the human body, so solid water is the most commonly used compensation material [7] in the plan of radiotherapy.

Currently the used tissue compensator is solid water compensator and homemade pigskin compensator. Solid water compensator is good uniformity, thickness uniformity, convenient to use. But using a U-shaped mask positioned, the compensator and the patient's skin cannot fit closely and leaving an air gap, influence dose correction effect especially in head and neck radiation therapy; The shortcoming of homemade pigskin as tissue compensator are not only the compensator cannot fit closely whit the patient's skin, but also uneven thickness, unsanitary and perishable and so on. Superficial tumors may be optimally treated with electron beam [8]. It has been suggested that clinical delineation of the target volume based only on the surgical scar may frequently miss the target, thereby impairing local control [9].

Our hospital radiotherapy using the Shandong Xinhua XHA600 monoenergetic 6 MV photons medical linear accelerator. Many cases need the compensator to be adjusted the radiation dose, especially the head and neck cases. By comparing, red wax produced tissue compensator can effectively corrected radiation dose to achieve the ideal dose distribution. This study compared radiotherapy planning target of before and after adding red wax compensator was the minimum radiation dose, the maximum dose, mean dose, target surface dose in the head and neck cancer patients. The results show that the red wax compensator was significantly improved target the minimum dose and target surface dose, but maximum dose and mean target dose no significant improvement, DVH and dose distribution graph also were improved significantly. While using tissue compensator has the following advantages red wax film production: the morphology can change with the skin form; fit closely with the skin; thickness can be adjusted according to the depth of the tumor; help to optimize radiation treatment planning; fixed and reproducible; production process simple and easy to store.

In summary, the use of U-shaped mask fixed red wax film production in conformal radiotherapy tissue compensator can significantly improve the surface dose and dose distribution superficial planning target volume and with skin fit well, easy to control the thickness and the production process simple, easy to store and good reproducibility, worthy of further promotion and application.

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