Abdomen Immobilization with Air Injected Balloon Blanket

Ye Lin Suh[1,2], Byong Yong Yi[1], Seung Do Ahn[1], Sang Wook Lee[1],
Jong Hoon Kim[1], Seung Ai Shin[2], Eun Kyung Choi[1]

[1]Radiation Oncology, Asan Medical Center, College of Medicine University of Ulsan,
[2]Dept. of Physics, Ewha Womans University
388-1, Pungnap-dong, Songpa-gu, Seoul, Korea
e-mail: yellinsuh@hotmail.com

ABSTRCT

The demand for a better immobilization device has been increased in the radiation oncology field. Especially, it is essential to have a reliable and practical immobilization tool for the whole body radiosurgery and the IMRT (intensity modulated radiation therapy). A useful method to immobilize the abdomen for the external beam radiation treatment is developed. The air-injected balloon blanket (AIBB) was designed as an immobilization device. As the air was injected into it, it pressed down the patient's abdomen and fixed the patient. The AIBB played a role not only to grab the patients' motion, but also to increase the patients' setup reproducibility. Patients' movements due to the respiration were reduced and the reconstruction could be maximized. The experimental results revealed that the AIBB could be used for the clinic.

Keywords: Immobilization, abdomen, setup, radiation therapy

1. INTRODUCTION

Developing modalities such as three-dimensional conformal radiation therapy (3DCRT) and intensity-modulated radiation therapy (IMRT) maximize advantages, if the patients' set-up err7ors can be minimized. Particularly, the thoracic/abdominal regions are difficult to immobilize due to respiratory motion. Therefore the ability to accurately and reproducibly position the patient is essential. With the use of appropriate immobilization or fixation devices, target positional inaccuracies can be reduced. Many reports have been demonstrated these devices, mainly based on the Alpha Cradle expanded foam or Vac-Lok evacuated cushion.[1-6] Since both are placed underneath the patients, the up-and-down movements of the abdomen, which moves most during respiration, cannot be immobilized for the supine-positioned patients.

Consequently new immobilization tool, which pressed down the patient's abdomen with an air-injected balloon blanket, was designed.

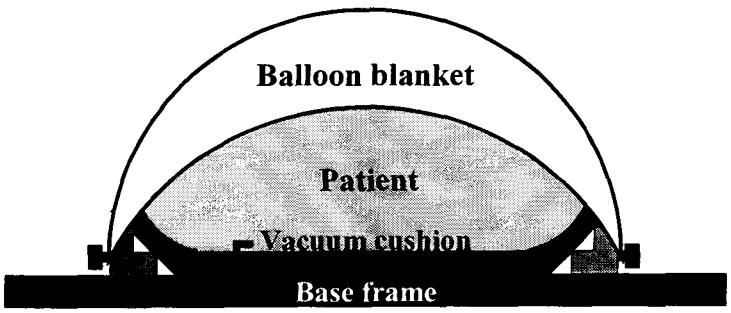

Figure 1. The scheme for the Air Injected Balloon Blanket

Acknowledgement: This work was supported by HMP-98-G-1-016 from MOHW(Ministry of Health & Welfare).

2. MATERIALS AND METHODS

Before designing the immobilization device, several requisites were considered. First, setting up the device must not take too much time during the simulation and treatment by simply implementing it. Second, though its role is to immobilize breathing motions, patients should not feel discomfort very much. Last, it should not obstruct the radiation treatment by attenuating the beams or causing some artifacts in radiographic images.

Figure 2. Patient lying down on the simulation with the AIBB

What we have designed consists of two different parts principally. One is the air-injected balloon blanket pressing down the patient's abdomen and the other is the segment fastening the blanket to the base frame. Two supporting structures to which three T-shaped hooks each adhered are attached on the both side of the blanket, a pressure gauge which controls the pressure inside the blanket, and a valve which is the gate for the air were attached to the blanket. The upper side and lower side of the blanket were made of different materials, because the upper side should not swell while the lower side should. This facilitated pressing down moving abdomen. Using the transparent feature for the blanket, it is possible to observe the beam field lights, crosshairs, distance indicator scale at the patient's skin and so forth.

In order to verify the effect and usefulness of our design, lung cancer patients were chosen. At the time of simulation, fluoroscopy was performed with and without the blanket. The pressure in the blanket for every patient was decided depending on the patient. With the patient in a supine position breathing freely, fluoroscopic movies were recorded in both A/P(anterior-posterior) and lateral directions, digitized at a rate of 29.97 frames per second, and analyzed by sampling video sequences every 10 frames.

3. RESULTS

The patient's movements could be classified into three major directions, which are the right-left, the anterior-posterior, and the superior-inferior directions. The range of the motion is about 8.6 mm in the right-left, 15.5 mm in the anterior-posterior, and 14.0 to 17.1 mm in the superior-inferior direction without the blanket, whereas 4.7 to 6.1 mm, 10.0 mm, and 13.0 to 15.8 mm with it. Table 1 summarizes each displacement due to breathing in three different directions.

With the help of our designed blanket, the displacement ranges were reduced up to 5.5 mm depending upon the directions of the motion. It was certain that the displacement along the anterior-posterior, which is the largest moving direction, was reduced noticeably – for example, more than 5 mm. These data indicated that the AIBB played an important role to reduce the patient's movement, by pressing down the patient's abdomen.

Table 1. Lung movements due to respiration with and without the AIBB(Air injected balloon blanket) in three different direction.

	Displacement range (mm)				
Direction	Left-Right		Anterior-Posterior	Superior-Inferior	
Without AIBB	8.6	8.6	15.5	14.0	17.1

With AIBB	4.7	6.1	10.0	13.0	15.8
Reduced by	3.9	2.5	5.5	1.0	1.3

4. DISSCUSION AND CONCLUSION

The resulted figures revealed that the AIBB could grab and reduce the patients' motions and be used for the clinic. It was more efficient that the large-moving directions of the patient's motion were reduced notably.

If the blanket lengthens, it can be more useful as covering the lower part of the chest and the pelvis and then can be used for besides lung cancer. AIBB can be also more practical by piercing some holes in the blanket and making the external surface of the blanket with writable feature, since marks can be putted on the skin through those holes and the lasers and treatment field borders can be marked on the blanket.[7] In addition if a few vertical lines backstitch on the lower side of the blanket, the balloon blanket would fit the surface of the patient's abdomen better. In case of emergency improving the blanket fixation parts are needed.

Evaluating the reproducibility of the patient's setup is needed to investigate more as to adjust accordingly for the next treatment session.

5. REFERENCES

(1) Saw CB. Yakoob R. Enke CA. Lau TP. Ayyangar KM. Immobilization devices for intensity-modulated radiation therapy (IMRT). Medical Dosimetry. 26(1):71-7(2001)

(2) Malone S, Szanto J, Perry G, Gerig L, Manion S, Dahrouge S, Crook J. A prospective comparison of three systems of patient immobilization for prostate radiotherapy. Int. J. Radiat. Oncol. Biol. Phys. 48(3):657-665(2000)

(3) Halperin R, Roa W, Field M, Hanson J, Murray B. Setup reproducibility in radiation therapy for lung cancer: a comparison between T-bar and expanded foam immobilization devices. Int. J. Radiat. Oncol. Biol. Phys. 43(1):211-216(1999)

(4) Bentel GC, Marks LB, Krishnamurthy R. Impact of cradle immobilization on setup reproducibility during external beam radiation therapy for lung cancer. Int. J. Radiat. Oncol. Biol. Phys. 38(3):527-531(1997)

(5) Bentel GC, Marks LB, Sherouse GW, Spencer DP, Anscher MS. The effectiveness of immobilization during prostate irradiation. Int. J. Radiat. Oncol. Biol. Phys. 31(1):143-148(1995)

(6) Nalder CA, Bidmead AM, Mubata CD, Tait D, Beardmore C. Influence of a vac-fix immobilization device on the accuracy of patient positioning during routine breast radiotherapy. British Journal of Radiology. 74(879):249-254(2001)

(7) Saw CB, Yakoob R, Enke CA, Lau TP, Ayyangar KM. Immobilization devices for intensity-modulated radiation therapy (IMRT). Medical Dosimetry. 26(1):71-7, 2001 Spring.