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The Guidelines of Laser on Lung Biopsy under CT Guidance

Min-Cheol Jeon[1], Man-Seok Han[2]*, Hyun-Soo Lim[1], Jae-Uk Jang[3], Seungyoul Lee[4], Yong-Kyun Kim[5] and Ik-Han Lee[6]

[1]Department of Biomedical Engineering, Chungnam National University and Department of Radiology Chungnam National University Hospital, Daejeon, South Korea; 99jmc@daum.net
[2]Department of Radiological Science, Kangwon National University, Samcheok 245-905, South Korea; angio7896@naver.com
[3]Department Radiation Oncology, Chungnam National University Hospital, Daejeon, Korea; linac@cnuh.co.kr
[4]Korea Food and Drug Administration, Cheongju, South Korea; dasom1022@hanmail.net
[5]Department of Radiotechnology, Daewon University, Jecheon, South Korea; kimyk66@hanmail.net.
[6]Department of Optometry, Gimcheon University, Gimcheon, South Korea; i4ueye@naver.com

Abstract

The purpose of this study was to evaluate the usefulness of laser guidance to target tissue within the lung, while applying Percutaneous CT-guided Needle Biopsy(PCNB) using two lasers. 64 MDCT(Multi Detector Computed Tomography), Chest phantom which was inserted with tissue in Bolus, 20 Gauge needle for biopsy, Two Lasers were used. When the needle puncture chest phantom, Two Lasers which were installed above head and next to side of the chest phantom guide the needle. Using the laser before and after was compared using a needle of biopsy. Each experiment was repeated ten times. As using laser, the average number of puncture was decreased from 2.2 times (before) to 1.4 times (after). It was decreased about 34%. Time of biopsy was decrease about 25%. DLP (Dose Length Product) was decrease about 17 %. PCNB by using two lasers can accurately do targeting tissue within the lung.

Keywords: CT-Guided Needle Biopsy (PCNB), CT (Computed Tomography) Guid Laser, Lung

1. Introduction

Various methods such as angiography, lymphography, and radioisotope scans are used for biopsy guidance. In particular, fluoroscopy, ultrasound devices, and Computed Tomography (CT) are widely used. CT-guide biopsy, which was first described by Haaga et al[1], allows placement of the biopsy needle to the precise location, even in small lesions, and examination of the great vessels surrounding the lesion site. It is widely used because it provides the advantage of visualizing the direction of the examination through its three-dimensional cross-sectional imagery[2]. CT-guided percutaneous biopsies allow precise location of target lesions. Percutaneous CT biopsies are cost effective as they shorten the period of admission to diagnosis, decrease the number of surgical procedures and shorten the time of hospital stay as well as require only local anesthesia[3].However, PCNB can lead to various complications because the needle penetrates lung tissues. To prevent complications, the number of needle punctures within a short time should be minimized. Hence the purpose of this study was to evaluate the effectiveness of reducing test time and radiation exposure dose by precisely directing the needle to the target lung tissue using two lasers.

2. Materials and Methods

Biopsy is performed under CT guidance using a human phantom for women, a 64MDCT(sensation64, Siemens, Germany), a 20 gauge needles of biopsy(TSK Laboratory,

*Author for correspondence

Japan), two lasers (HG-909A, Mini-588). Since the phantom had no carcinomatous tissue component, artificial tissues were grafted into it. For the artificial tissue grafting into the phantom, the inner part of the body-equivalent material (bolus) was designed into the shape of a lung. Then, a piece of sponge was inserted, followed by a large, round glass material, which had a diameter of 1.5 cm and higher radiation attenuation (Figure 1).

The output power of the HG-909A laser is 1mw and the wavelength range is between 645nm to 680nm. The Mini laser output power is 5mw which produce the wave-length between 630nm to 680nm. By positioning the Phantom in an appropriate location, the metallic line marker was used on the phantom's skin over the area of interest to focus the optimal access point (Figure 2).

A Topogram of the entire chest was taken and CT scan of the interest region was obtained respectively, and from images, a final table position, puncture depth and angle of needle were determined based on the multi planar correction (Figure 3).

CT image through the region of interest had been obtained with a slice thickness of 2 to 2 mm and viewed under a combination of soft tissue and lung window setting. After moving phantom to the region of interest, the level is marked over the phantom's skin with laser beams emitted from CT scanner (Figure 4).

This method which does not apply laser beams, the angle is set using a protractor and an assistant guides the technician to align the needle with the protractor angle. Once the needle is aligned with the protractor angle, a needle puncture is made (Figure 5).

By using two laser beams, the marked area is aligned horizontally and vertically. The technician holds a 20-gauge biopsy needle using hemostatic forceps and inserts the needle in the lesion. Once the biopsy needle placed in correct position slightly pushing toward the target tissue site with guidance by the two laser beams (Figure 6).

After needle placed, CT was performed to confirm needle tip position into tissue. The experiment was performed by comparing needle position with and without laser guidance.

First, with the phantom in the prone position, a needle is inserted vertically in the tissue, 8 cm deep from the surface of the skin. Second, in the prone position, a needle is

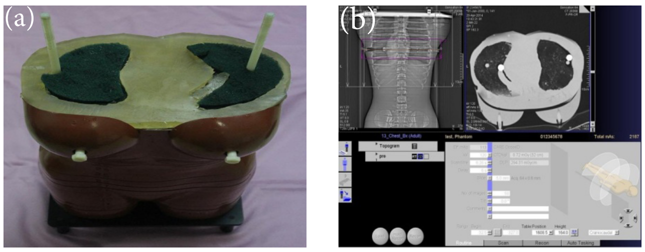

Figure 1. The inner part of the body-equivalent material (bolus) was designed likea lung shape .The piece of sponge was placed inside the bolus (a). After insertion of the 1.5 cm (in diameter) rounds glass material, a CT scan was obtained (B).

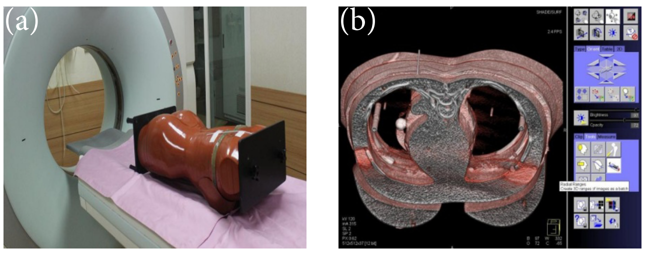

Figure 2. A Metallic line marker was placed on the phantom's skin over the area of interest (a). The VRT image was obtained after the CT scan (b).

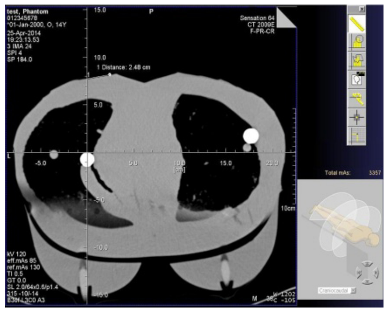

Figure 3. CT scan of the region of interest was obtained, and from images, a definite table position, puncture depth and angle of needle were determined.

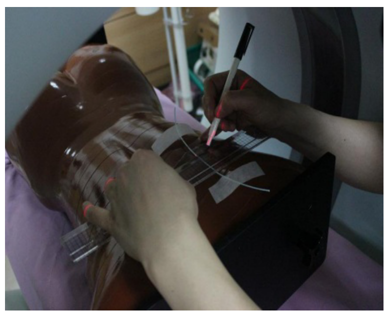

Figure 4. After moving phantom to region of interest, the level was marked over the phantom's skin with laser beam emitted from CT scanner.

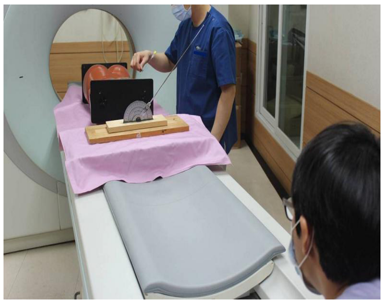

Figure 5. The assistant helps aligning the needle with the protractor angle and ensure that the needle puncture is at the precise location.

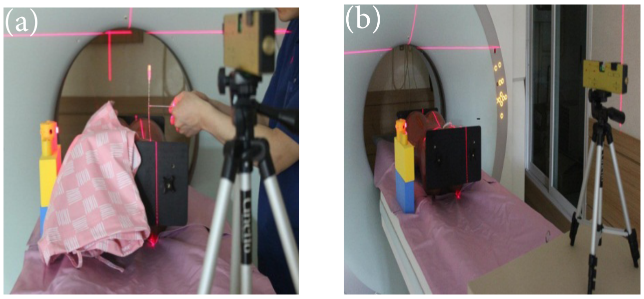

Figure 6. The vertical and horizontal alignment of the marked area using two laser beams (a). The technician holds a 20-gauge biopsy needle using hemostatic forceps and inserts it in the lesion. Once the biopsy needle is in place, it is slid toward the target tissue site with guidance of the two laser beams (b).

inserted in the tissue, 3 cm deep from the surface of the skin, at the 45-degree angle. Third, with the phantom in the decubitus position, a needle is inserted vertically to the tissue, 8 cm deep from the surface of the skin. Each experiment was repeated ten times.

3. Result

3.1 Number of Needle Punctures

The number of needle punctures were compared in both methods, the results shows that the CT imaging is 1.4 with laser guidance and 2.2 without laser guidance. Thus, laser guidance reduction 34% in the number of needle punctures made (Table 1).

3.2 Time Required for Biopsy

The time required for biopsy is defined as the duration from the time a scout CT scan of the phantom was obtained to the time when the precise location of the needle puncture in the target tissue was verified through CT imaging. The time required for biopsy is around 549.4 ± 212.6 seconds without laser guidance and 414 ± 68.5 seconds with laser guidance. Laser guidance resulted in a 25% reduction in the time required for biopsy (Table 2).

Table 1. Comparison of the number of needle punctures between with and without laser guidance. (Unit: n)

	Without laser guidance	With laser guidance
The average number of biopsy	2.2	1.4

3.3 The Result of Radiation Exposure Dose

The mean radiation exposure dose measured using DLP was 497.13 ± 114.44 mGy·cm without laser guidance and 412.23 ± 66.45 mGy·cm with laser guidance, resulting in 17% reduction in radiation exposure (Table 3).

3.4. Images of Precise Tissue Targeting with Laser Guidance

VRT images of the three show that the needle is correctly inserted into the internal tissue of the phantom. Each VRT images have difference that were position of phantom, depth of tissue and angle of needle (Figure 7).

4. Discussion

As physical examination using CT has become prevalent, small pulmonary nodules, which is not observed using the existing simple radiography, have been more frequently discovered[4]. Considering that approximately 50% of pulmonary nodules discovered through CT is related to malignant tumors[5], histological diagnosis is required for appropriate treatment[6]. Percutaneous CT-guided Needle Biopsy (PCNB) of the intra thoracic lesions is a well-established technique for obtaining tissue for

Table 2. Comparison of the time required to obtain a CT scan between with and without laser guidance

	Without laser guidance	With laser guidance	Rate of change(%)
	second	second	
The average time of biopsy	549.4±212.6	414±68.5	25

Table 3. Comparison of DLP measurement between with and without laser guidance

	Without laser guidance	With laser guidance	Rate of change(%)
	mGy·cm	mGy·cm	
DLP	497.13±114.44	412.23±66.45	17

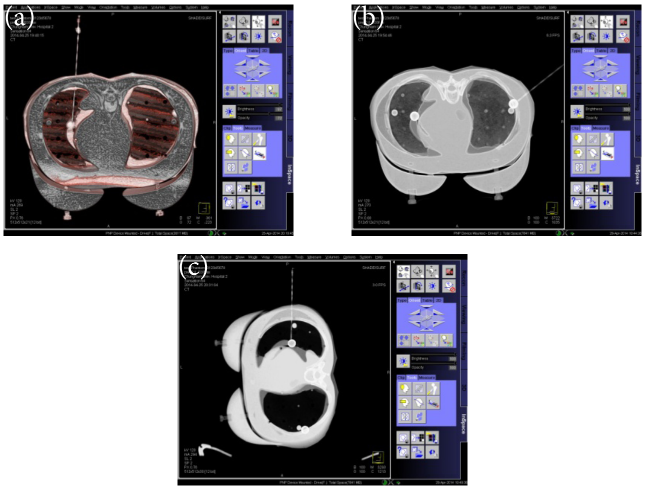

Figure 7. VRT image of a needle punctures 8 cm deep into the tissue, with the phantom in the prone position (a). VRT image of a needle puncture 3 cm deep into the tissue, with the phantom at a 45-degree angle in the prone position (b). VRT image of a needle puncture 8 cm deep into the tissue, with the phantom in the decubit us position (c).

histopathological examination and various other tests[7]. PCNB is integral in the diagnosis and treatment of many thoracic diseases, and is an important alternative to more invasive surgical procedures. Despite observing all pre-caution, complications may occur. Complications of PCNB include pneumothorax, hemoptysis, hemothorax, infection, and air embolism, with the most common com-plication as pneumothorax[8]. To prevent complications, the number of needle punctures to the lung tissue must be minimized by precisely directing the needle to the target lung tissue upon entry to the outer layer of skin.

The results of this study indicate that the number of needle punctures of 2.2 without laser guidance was decreased to 1.4 with laser guidance. This implies that risks for com-plications to PCNB, such as pneumothorax, hemoptysis, hemothorax, infection, and air embolism, can be reduced.

The time required for biopsy was reduced from 549.4 ± 212.6 seconds without laser guidance of 414 ± 68.5 seconds with laser guidance, indicating a 25% reduction under laser guidance. This is an indication that the time required for biopsy was reduced owing to the reduced number of needle punctures.

In the comparison of the DLP measurements according to the CT equipment used, the DLP was 497.13 ± 114.44 mGy·cm with the use of a protractor and was 412.23 ± 66.45 mGy·cm with the use of laser beams, indicating a 17% reduction with the use of laser beams. However, this study was a limited in that the patient's breathing or movement could not be exactly recreated during the study because a phantom was used instead of a patient.

When performing PCNB guided by two laser beams, malignant lung tissues were inserted in the phantom and a precise needle insertion to the malignant tissue was achieved after 1.4 attempts.

5. Conclusion

Therefore, application of the study technique in clinic practice will increase the precision of biopsies, the time of biopsies will be decreased accordingly. In addition, risks of complications and radiation exposure doses will be reduced owing to the decreased number of needle punctures.

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