ORIGINAL ARTICLE

Using a String Scar Marker with Iodine for CT Simulator in Breast Cancer Cases

Penggunaan String Scar Marker dengan Yodium untuk CT Simulator Kasus Kanker Payudara

Bun Veasna[1], Nurbaiti[2], Nursama Heru Apriantoro[2]
[1]Khmer Soviet Friendship Hospital, Phnom Penh, Cambodia
[2]Poltekkes Kemenkes Jakarta II, Jakarta

Corresponding Email: nurbaiti@poltekkesjkt2.ac.id

ABSTRACT

Breast radiotherapy in breast cancer patients often uses CT landmark wires to pinpoint the area of breast scars for appropriate treatment. Most commercial CT marker wires are expensive and made of high-Z materials that cause scratch artifacts. In hospitals, scar markers are made from nylon string with an iohexol contrast medium. This research aims to analyze a simulation of a CT examination in breast cancer cases using a string scar marker with iodine and analyze its characteristics. For this reason, the authors created a new breast CT scar marking wire using nylon rope combined with iodine contrast media in CT simulations of breast cancer cases for treatment planning. Three patients were scanned using a string scar marker developed with iodine for breast cancer in the hospital's CT simulator facility. As a result, using a computer console, the CT number showed this string scar marker had clear visibility and did not produce artifacts. In conclusion, this new string breast scar marker is fast, flexible, and inexpensive. This is beneficial for the treatment of breast cancer patients.
Keywords**: **breast cancer, CT simulation, immobilization devices, string scar marker

ABSTRAK

Radioterapi payudara pada pasien kanker payudara sering menggunakan penanda CT untuk menentukan area bekas luka payudara dengan tepat untuk mendapatkan pengobatan yang tepat. Sebagian besar kawat penanda CT komersial harganya mahal, terbuat dari bahan Z tinggi yang menyebabkan artefak tergores. Di rumah sakit digunakan penanda bekas luka yang terbuat dari benang tali nilon dengan media kontras iohexol. Tujuan penelitian ini adalah menganalisis simulasi pemeriksaan CT pada kasus kanker payudara menggunakan string scar marker dengan yodium dan menganalisis karakteristiknya. Untuk itu, penulis membuat penanda bekas luka CT payudara baru menggunakan tali nilon yang dipadukan dengan media kontras yodium dalam simulasi CT kasus kanker payudara untuk perencanaan pengobatan. Tiga pasien kanker payudara dipindai menggunakan tali penanda bekas luka ini di fasilitas simulator CT rumah sakit. Dengan bantuan perangkat lunak konsol tomografi komputer diperoleh nilai CT number yang menunjukkan hasil penanda dengan visibilitas jelas dan tidak menghasilkan artefak. Kesimpulannya, string scar marker yang baru ini dapat dibuat dengan cepat, fleksibel, murah dan bermanfaat bagi pengobatan pasien kanker payudara.
Kata Kunci: **CT simulation, kanker payudara, perangkat imobilisasi, string scar marker**

INTRODUCTION

In the world, breast cancer affects women more frequently than any other cancer, accounting for 11.7% of all occurrences(1). Breast cancer is the second leading cause of cancer death for women in Asia(2). In 2018, breast cancer in Southeast Asia was recorded at 137.514 cases, with a death rate of 50.935(3). Breast cancer cases rank second after cervical cancer in

Indonesia, and the number of cancer cases reached 2.459 (13.5%)[4]. The increasing instances of cancer globally are estimated to occur by up to 47% from 2020 to 2040[1]. For this reason, good cancer prevention and therapy efforts are needed.

To guarantee total tumor cell death, treatment usually starts with surgery, either a lumpectomy or a mastectomy, and is then followed by radiation therapy as an adjuvant[5]. Surgical scar markers are essential for 3-dimensional radiotherapy planning in CT simulations because they show microscopic tumor spread sites that should be taken into account when preparing an irradiation regimen[6]. For planning radiotherapy treatments, radiolucent scar markers with a low atomic number and a mass density equal to water density make it easy to see, cause the least amount of radiation dose interference, and are convenient[7].

Wire markers made of metal are frequently utilized in simulation techniques, resulting in streaking and mistaken CT images[8]. Disposable scar markers are available in sizes 1 and 2 millimeters, selling for around USD 117 per box[9]. Some radiation centers create affordable scar marker materials due to limited availability. A powdered scar marker substance was developed in India in 2018 using low-atomic-number materials, allowing for customization of size and shape[10].

Radiocontrast media enhances image contrast in imaging technology, increasing the visibility of internal structures. Common materials include barium-based (oral) and iodized (intravenous) materials. Barium is used in metallurgy, fireworks, oil drilling, and radiology. Due to its toxicity, iodine (Z53) has historically been the preferred contrast media for CT scan imaging [11].

Nylon, invented by Wallace Carothers in 1935, is a petroleum-based synthetic material. It is renowned for its robustness, low weight, and ability to repel dirt. Nylon thread, sometimes called polyamide thread, is categorized into two types: nylon six and 6,6 or nylon 66. Nylon 66 exhibits a higher degree of crystallinity and organization, rendering it less susceptible to bending. Nylon 6 is preferable for producing string scar markers because it consists of a single monomer with six carbon atoms, has a lower melting temperature, absorbs water, and is a lightweight engineering plastic. Both materials have applications in manufacturing, automotive, construction, and textiles [12].

The Radiotherapy Department at Siloam MRCC Hospital utilized nylon rope thread scar markers in conjunction with iohexol as a radiocontrast medium, which led to distinct visibility, user-friendly application, and low artifacts in CT simulator image outcomes. The author's thesis, titled "Analyze using a string scar marker with iodine in breast cancer cases for a CT simulator," investigates the application of a radiocontrast medium in generating CT scar markers. This research aims to examine the CT simulation of breast cancer employing string scar markers containing iodine and to analyze the properties of these markers after image capture.

METHODS

This study employs a descriptive methodology, utilizing observation techniques while capturing images using a string scar marker containing iodine on the CT simulator for breast cancer. This book's research was conducted from October to November 2023 in the Radiotherapy Department of Siloam MRCCC Hospital. The population and sample for this study were derived from individuals who underwent CT simulation for breast cancer, utilizing a string scar marker containing iodine. The research employed various instruments, such as worksheets for documenting the outcomes of tools and materials used in simulating breast cancer, a string scar marker with iodine, a CT simulator unit, immobilization devices, stationery offices, and a camera for recording the author's observations. The data collection technique involves the author's observation of using a scar marker and its application to patients. The author then analyzes the resulting images using computer console software outside the CT simulator room. Additionally, data is gathered from various sources, such as books, websites, and journals. This data will be utilized to develop theories, support the collected data, and establish guidelines for the research.

RESULTS

The result was conducted by the author in the Radiotherapy Department at Siloam MRCCC Hospital on the use of a string scar marker during CT simulation for radiotherapy treatment of breast cancer. This research data was processed and analyzed from observation and documentation.

Based on research, when creating a string marker, we typically utilize a 2mm diameter nylon wire and a contrast medium known as Iohexol, which is present in 300mg/ml concentration and comes in 50 ml bottles. The amount of iohexol contrast medium utilized depends on the number of nylon wires needed for daily patient scanning. Subsequently, the nylon wires are immersed in the iohexol container for 3 to 4 hours and air-dried for approximately 30 minutes following the scanning process. See in figure 1.

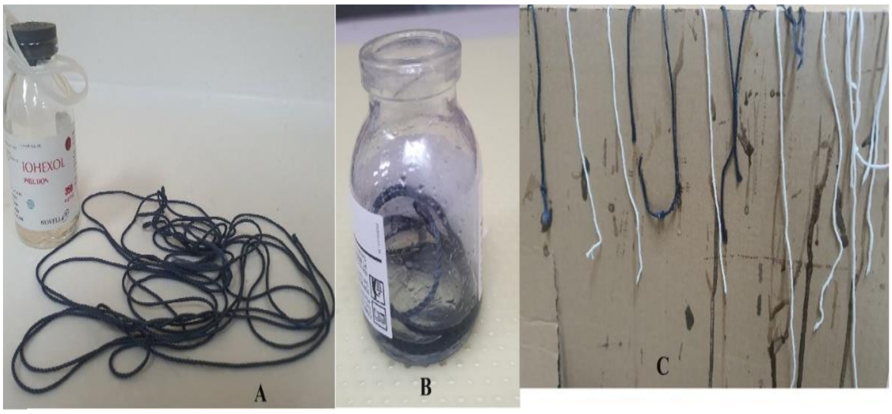

Figure 1. Nylon Thread wire and Iodine(A), nylon soaked in Iohexol contrast media (B), and nylon dried (C)

Before conducting CT simulations for breast cancer, radiation therapists evaluate patients' pregnancy status, the presence of implanted devices, and any contraindications, taking into account the preparation of patients and tools. Documentation is used to verify the accuracy of patient information. Patients are informed about the CT simulation procedure and the duration of the scanning process. The key immobilization instruments utilized in the CT simulation procedure comprise a breastboard, loc-bar index, headrest, knee rest, breast thermoplastic mask, and a water tank employed to soften all plastic masks. Stationery instruments like micropores affixing string scars and lead ball markers, creating reference points using blue permanent markers, and utilizing crosshair plastic markers to maintain three reference points separate from the skin.

Based on the observed patient setup and image acquisition, the patient lay down on the Klarity breastboard attached to the flat table via a loc-bar indexer in a straight head-first supine position with a breastboard inclination of 7.5 degrees. A red headrest will be under the patient's head, and arms will be raised above their head on armrests that can be adjusted for arm comfort. Set three reference points at the level of the nipple or laser at 15 mm, throw both sides on the breast board, and then attach string markers to the patient's skin by micropore tape. The use of breast masks soaked in water baths serves on patients for fixation and immobilization during the scanning and irradiation. Lead markers attached to three met lasers marked on the breast mask. Scanning is carried out on the CT Simulator operator console for breast cancer cases with a string scar marker localization target, a tomogram image with reasonable boundaries, and a slice thickness of 3 millimeters. See in figure 2.

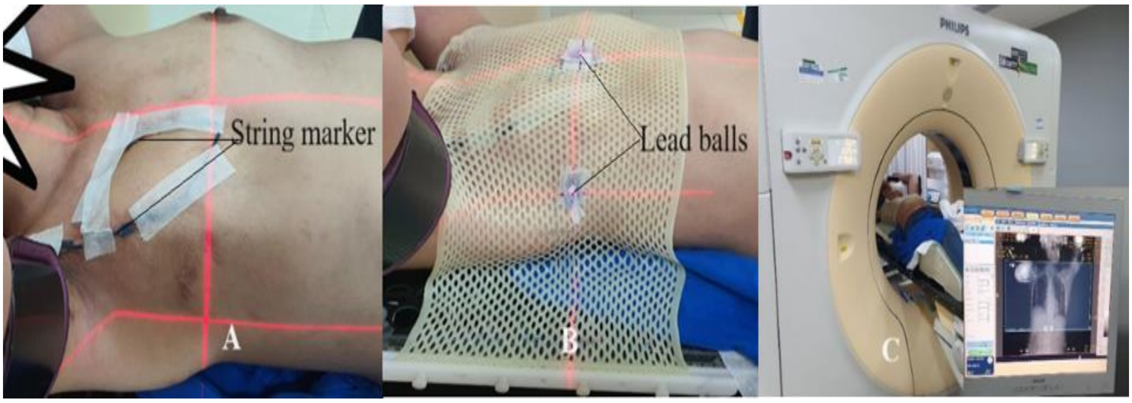

Figure 2. String breast marker adhered to skin scar by surgical tape(A), Breast mask fixed to the body, lead balls stuck to the reference point(B), image acquisition(C)

Based on the results, images were displayed using a computer tomography console software checking the characteristics of the string scar marker affected on images. We can check each density or CT number of the string breast scar marker. Select the arrow clip box tool, place the cursor mouse on interest areas, and then click. The CT numbers will appear (1779, 1732, and 2011), as shown in Figure 3.

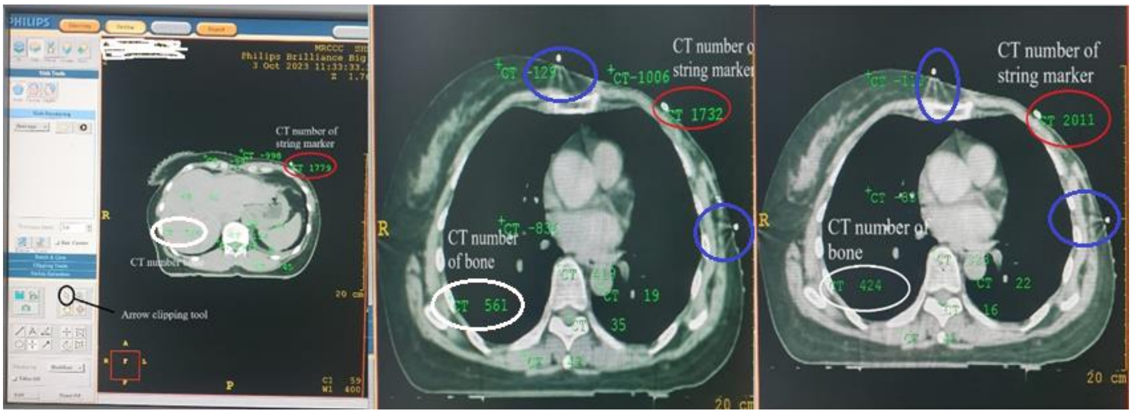

Figure 3. Using the CT console software, the blue circle is lead markers, the red circle is CT number string markers, and the white circle is CT number bone

DISCUSSION

Based on the results of the research, three patients were using string scar markers for breast cancer on the CT simulator. It has been demonstrated that a string scar marker (red circle) is easy to develop and cut out in small pieces, is flexible, more accessible to form into desired shapes of the lesion scar, and denotes the area of concern without lifting or coming off. It is visible as bright dots on the skin scar without producing streaking artifacts on the surrounding normal structure and tumor sites. Figure 3 shows that the string breast scar markers have CT numbers of 1779, 1732, and 2011. These are very close to the densities of human bone, which are 510, 561, and 424, with a rank of about 3000 HU[13].

The three lead point markers (blue circles) are metallic markers used in CT scans to find a starting point for treatment planning. They can add streak artifacts and reflected shadow shapes from high-attenuation lead materials to the images, changing the actual density of normal tissue and making it hard to understand the results. It can cause the dosimetrist to spend more time determining the distortion and matching the affected tissue with the hounds-field units of nearby tissue unaffected by the distortion. The artifacts can obscure the area of interest and make it harder to detect small lesions that affect radiation dosage calculations.

The therapist or radiation oncologist can align the marker with the desired area of treatment, and measuring the exact length of the skin scar is also simplified, as it only involves using tools such as calipers, rulers, or software to measure the dimensions and distances of the scar marker on the images[14–16]. In preparing radiotherapy, the critical thing to be done is to identify the target area that will receive radiation with a scar marker. A string scar marker with iodine is useful. This method makes marking the area easier than other materials, such as tattoos, marker pens, or henna[17].

The use of string scar markers containing iodine on the CT simulator helps plan breast cancer radiotherapy by identifying the anatomical structure of the cancer correctly, thus helping with therapy planning and using optimal radiation doses. Patients are expected to receive the minimum level of radiation possible to treat their breast cancer without damaging the surrounding healthy tissue[7].

CONCLUSION

A nylon-based iodine breast scar marker wire is a useful instrument for radiation therapists and medical physicists, as it produces high-quality CT pictures that are free from streak artifacts. The wire delineates the boundary of the radiation field, enabling the administration of whole-breast irradiation with or without a boost. It establishes the boundaries of the treatment field by creating medial and lateral breast tangents as well as superior and inferior field borders. The pliable wire may be easily shaped to fit the desired area, reducing the need for manual shaping and ensuring precise measurement of scar length and position for treatment planning. Additionally, it can denote different anatomical regions in CT scans for radiotherapy.

RECOMMENDATION

Prior to the scan, the radiation therapist should ensure the proper usage of immobilization equipment and consult with the radiation doctor or medical physicist to accurately determine the location of the scar and other tumor sites. Avoid using metallic markers while scanning images as they might adversely affect image quality and impede accurate dose determination.

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