PRACTICAL AND APPLIED MEDICAL PHYSICS

A Website for Teaching Tubestand / Bucky Alignment Principles

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Abstract—**Even in the world of digital imaging, fundamental physics principles still apply. Misalignment of the x-ray tube and image receptor can cause image distortion, grid artifacts, and phototiming errors. A website was developed to illustrate these principles using a multi-modality approach. In addition to explanations of the effects of misalignment, the website also includes videos as well as a simulator demonstrating how stationary radiographic systems achieve alignment.**

Keywords— **Radiography, Grids, Artifacts**

I. Introduction

Even with the many technical advances is the field of radiographic imaging, fundamental physics principles such as image geometry and grid alignment remain as important as ever. Stationary radiographic systems still hold an advantage over mobile equipment in their ability to provide superior image quality through accurate and consistent alignment of the x-ray tube and image receptor.

Radiology resident physics education at Georgia Regents University begins with a series of hands-on laboratories in an x-ray room. Since they are entering a career in which they are likely to be involved in equipment purchases as well as the supervision of technologists, we felt it important for residents to understand radiographic systems. We also felt it was important to understand the advantages in terms of image quality and consistency provided by stationary equipment, and how the equipment provides these advantages.

The first physics laboratory for new radiology residents consists of an observational tour of an imaging suite. Included in this lab is a demonstration of the tubestand and the way it provides alignment of the x-ray tube to the image receptor. In addition to the obvious radiation safety advantages of imaging in a shielded environment, the image quality advantages of stationary radiographic equipment over mobile units are discussed. The importance of alignment to image quality is emphasized.

In later laboratories, residents make radiation measurements to demonstrate the effects of radiographic technique, automatic exposure control, and changes in absorbers. As part of these later labs, residents are expected to be able to correctly operate the tubestand to satisfy the various system interlocks.

While most textbooks on radiology physics discuss image geometry, distortion, and grid cutoff, there is little on how equipment assists in achieving correct alignment of the x-ray tube to the image receptor. The work described here was an effort to develop a website which illustrates the lessons demonstrated in our physics lab. Websites offer flexibility in the presentation of material not possible in a textbook. In addition to text descriptions and figures, the website offers two additional features. The first was the inclusion of several short video segments showing the use of alignment tools provided by stationary radiographic systems. The second element is a tubestand simulator demonstrating the process of equipment positioning.

II. Methods

Because radiology residents do not routinely spend much time working with radiographic systems, a web site was developed to not only describe the importance of proper geometry to image quality but also how a stationary radiographic system achieves this geometry. The importance of alignment to image quality is emphasized, as it relates to geometric distortion as seen in figure 1.

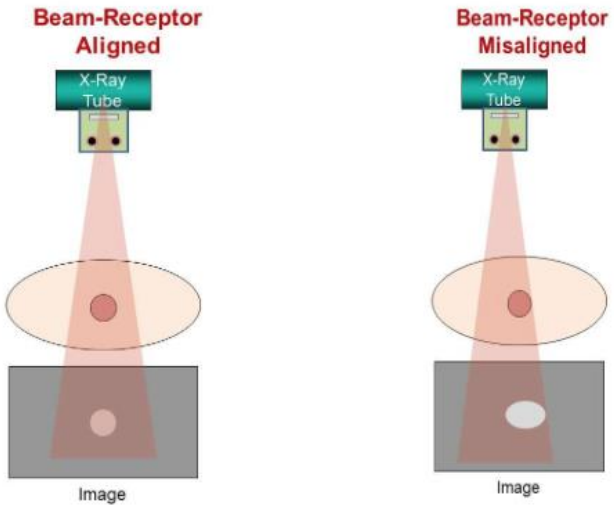

Fig. 1 Image Distortion Caused by Misalignment of the Tube and Receptor

Also described is the importance of alignment with the use of a grid. The various types of grid misalignment and the effect of each on the appearance of the image and on patient dose are described using text and graphics as seen in figure 2.

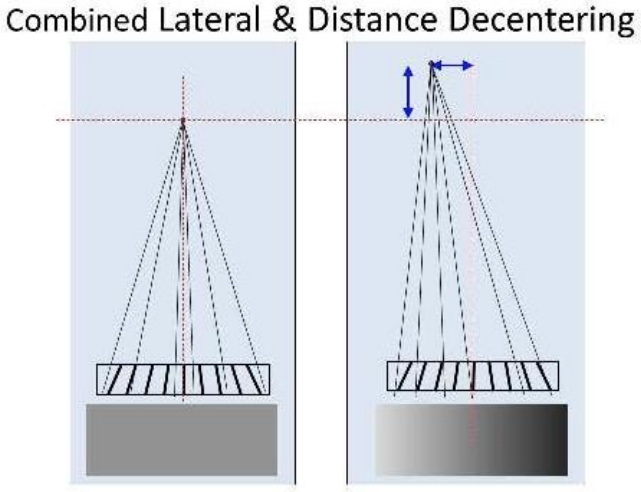

Fig. 2 Graphic Illustrating Grid Misalignment Artifact

Stationary radiographic units incorporate alignment tools not available on mobile systems. Our web site highlights these tools along with photos and videos showing tubestand manipulation. An example is shown in figure 3.

Fig. 3 Embedded Video Showing Tubestand Alignment Process

The site also includes a simulator demonstrating tubestand alignment. Either tabletop or bucky mode can be selected. The user can move the tube in the longitudinal, lateral, and vertical while the bucky can be moved longitudinally. When bucky exposure mode is selected, the user cannot get a "ready" light until the lateral and vertical detents are engaged. As is the case for actual systems, longitudinal alignment is accomplished manually. The simulator is shown in figure 4.

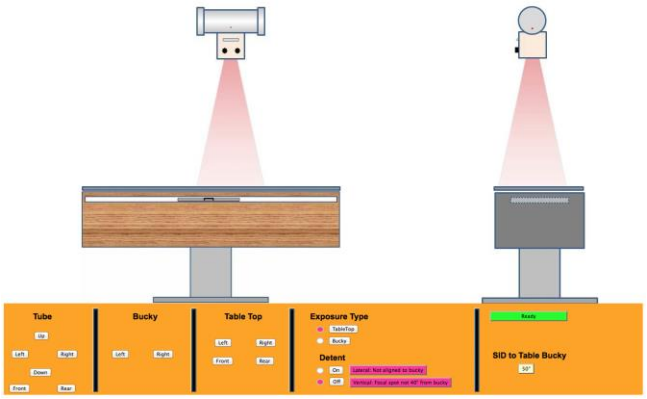

Fig. 4 Tubestand Simulator

III. DISCUSSION

An important aspect of achieving quality is the identification and reduction of variation in a process. Stationary radiographic equipment provides tools allowing the technologist to achieve a consistency in the alignment of the x-ray tube to the image receptor that is impossible using mobile radiographic equipment.

While mobile imaging should only be performed if a patient cannot be transported to stationary equipment for radiation safety or for medical reasons, this is often not the case in practice. It is not uncommon for mobile examinations to be performed because hospitals do not have transport personnel after normal work hours or for other reasons unrelated to the medical condition of the patient.

It is important for radiologists to understand how stationary systems provide positioning consistency and the compromises to image quality and radiation safety associated with mobile examinations. Radiologists need to be able to interact with technologists and administrators to ensure mobile exams are only performed when medically necessary and not for the sake of convenience.

Identification and understanding of the issues associated with mobile examinations are components of the education of radiology residents. At Georgia Regents University, this education begins with a series of laboratories in stationary x-ray rooms where alignment tools can be demonstrated. A web site was developed to illustrate the physics principles associated with misalignment such as distortion and grid effects. The web site uses photographs, videos, and a tubestand simulator to teach alignment principles previously only available in laboratory classes.

The website described here can be accessed at the following link:

http://www.gdavidasp.net/Tubestandsim/Index.html

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