Radiography 21 (2015) 288–293

Contents lists available at ScienceDirect

Radiography

journal homepage: www.elsevier.com/locate/radi

Review article

Bariatric diagnostic CT scanning: A radiotherapy perspective

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ARTICLE INFO

Article history:
Received 19 November 2014
Received in revised form
27 December 2014
Accepted 30 December 2014
Available online 15 January 2015

Keywords:
Collaboration
Bariatric
Computed tomography
Manual handling

ABSTRACT

Obesity is increasing in the United Kingdom. Equipment available for this patient group including wheelchairs, beds and hoists is becoming more common in the hospital environment; diagnostic imaging equipment that can accommodate bariatric patients has not increased at the same rate. Subsequently these service-users are often unable to receive "gold-standard" cross-sectional imaging within their patient-pathway. This paper highlights how a diagnostic imaging department has utilised wide-bore CT scanning equipment within the radiotherapy setting to ensure an equitable service for all service users. Through literature review and local experience, a standard operating procedure and scanning service has been developed. Areas explored include technical consideration of scanner design; patient positioning; image artefacts and intravenous contrast administration. Also investigated is patient well-being incorporating manual handling, respiration and psycho-social needs. Additionally, demonstration of how interprofessional collaboration by diagnostic and radiotherapy radiographers can ensure the best imaging experience and outcome for this patient group.

Introduction

Over the past two decades obesity has been steadily rising in England.[1] Obesity is described in terms of body mass index (BMI) which is defined as the weight in kilogrammes divided by the square of the height in metres (kg/m^2).[2] A BMI greater than 30 is considered to be obese[3] – Table 1. In England between 1993 and 2012 the proportion of obese adults increased from 13.2% to 24.4% among men and from 16.4% to 25.1% among women.[4] Estimates have been made that 60% of men and 50% of women will be obese by the year 2050.[5]

Healthcare equipment available for severely obese patients is becoming more common in the hospital setting. Beds, wheelchairs and hoists have all been made to be physically larger with higher weight capacity[6] to accommodate this demand. These small pieces of equipment can be purchased and/or leased as required, moved around the hospital to where they are needed or used in a ward environment. While imaging equipment has evolved with increased table weights and wide bore MRI and CT scanner options, it is the authors' observation that these larger pieces of equipment are fixed in one place and are expensive to purchase. Moreover, it is not so easy to keep up with this demand and once purchased a scanner will be in service for approximately 10 years[7,8] and so there will be a time lag for facilities to catch up with the demand of bariatric CT scanning.

The industry standard aperture in CT design is 70 cm due to image quality requirements[9] and consequently diagnostic imaging departments have not embraced wide-bore technology. This contrasts with radiotherapy departments who have adopted gantry apertures of up to 90 cm for pre-treatment planning purposes. In this context wide apertures are deemed necessary to accommodate patients with minimal compromise to their required treatment position. Subsequently utilising wide-bore CT scanners, available in the oncology setting, for diagnostic bariatric scanning allows for a group of patients to have the imaging they need.

In response to an increasing local demand to scan the bariatric patient group and with collaboration between the radiotherapy and diagnostic departments, a local standard operating procedure was developed so as to offer a CT scanning service for bariatric patients via the wide-bore scanner within the radiotherapy department-appendix 1. The aims of producing a procedural document was to act as a guide for radiologists requesting CT scans of this patient group and also to provide instructions for the CT booking team and diagnostic radiographers so as to ensure optimal image quality is achieved.

The purpose of this paper is to explore how current literature and research findings informed the design of this document. The paper seeks to achieve this by outlining technical scanning factors,

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http://dx.doi.org/10.1016/j.radi.2014.12.013
1078-8174/

Table 1
Body mass index. World Health Organisation (WHO) classification.

BMI kg/m^2 classification	
18.5–24.9	Normal
25–29.9	Overweight
30–39.9	Obese
>40	Extreme "Morbid" Obesity

discussing workforce requirements and reviewing patient well-being considerations. As there is limited published work in this area of cross-professional working between diagnostic and therapeutic departments this article also includes some vignettes so as to illustrate how local experiences have helped formulate this document. All images included have full written patient consent.

Technical scanning considerations

Scanner design

The scanner available locally is a 16 slice Philips Brilliance Big Bore CT scanner (Philips Healthcare, 2014) and has a bore diameter of 85 cms and a couch weight limit of 295 Kg-Fig. 1. Observation of this weight limit is crucial due to the precise motorised table movements which are important for z axis accuracy as the table moves through the gantry.[10] However weight isn't the only issue and the patient's circumference also needs consideration. While the term bariatric means large or heavy it covers a wider population than the BMI definition of obese and extremely obese. This is due to limitations of this measurement tool which is unable to differentiate between lean and fat mass or to characterise the distribution of body fat.[11] Consequently some patients may fall into bariatric guidelines even if their weight BMI is lower than the accepted WHO classification (Table 1) owing to their weight distribution and girth size.[12] Although the use of an appropriate sized hula-hoop or plastic ring is advocated in literature to determine girth size,[10] it must be highlighted that a person's shape will change with their position as they lay down. Furthermore, the CT table takes up a portion of the gantry such that the vertical gantry diameter maybe diminished up to 20 cm to accommodate the flat-top table that is standard issue for radiotherapy CT scanners.[13,14] Subsequently an antero-posterior (AP) and lateral measurement will determine the ability to fit through the scanner's bore rather than a measurement of girth.

Patient positioning

Accurate patient positioning is crucial for any CT procedure however, extra considerations are required for scanning bariatric patients. The patient should be positioned so that the area of interest is in the Field of View especially where the girth exceeds this.[15] Positioning the patient feet first may help if the chest girth precludes abdominal imaging.[11] Android obesity, the "apple-shaped" accumulation of fat around the abdomen, is often unstable and asymmetric.[16] The pannus of a morbidly obese adult can weigh up to 45 kg[17] and if it settles to the side as the patient lies can lead to beam hardening from lateral projections and photon starvation artefacts. Fig. 2 demonstrates local experience of this with a patient referred to the department for an abdominal scan to assess the extent of his hernia. When the patient first lay down the hernia settled to one side and would not fit through the bore of the scanner. The radiographer had to position the patient's pannus so it rested anteriorly. An alternative technique to consider in these instances, described in the literature, is "bundling" which involves wrapping the patient in a sheet prior to scanning to present a more symmetric profile, thus reducing artefacts). It may also give the patient some reassurance as they often have a fear of falling from the narrow couch if their abdomen should shift.[13]

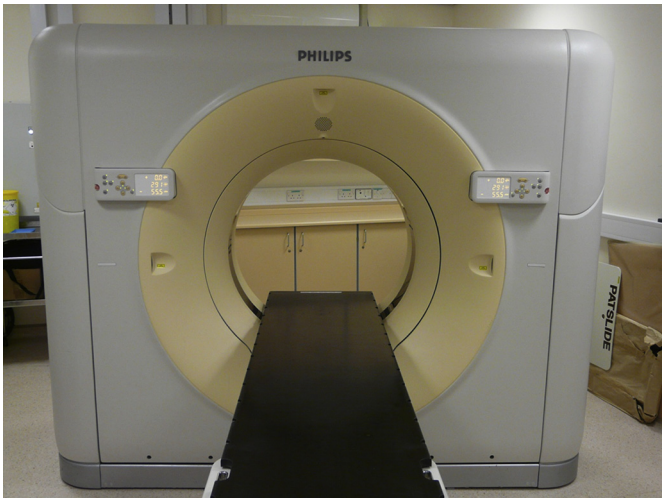

Figure 1. CT scanner with couch in the bore.

Image artefacts

Although it may be difficult for bariatric patients to raise their arms above their head, it is important to do so as beam hardening artefacts can result from arms by sides as well as further physical limitation within the bore.[18] Other artefacts to be aware of are ring artefacts-demonstrated in Fig. 3. This is normally attributed to a detector out of calibration whereby the scanner will give a consistently erroneous reading at each angular position, resulting in a circular artefact. However in bariatric scanning it is the result of a detector over ranging whereby the reference detectors at the edges are covered by the patient so inaccuracy occurs as this mimics a damaged detector. In these situations it is worth

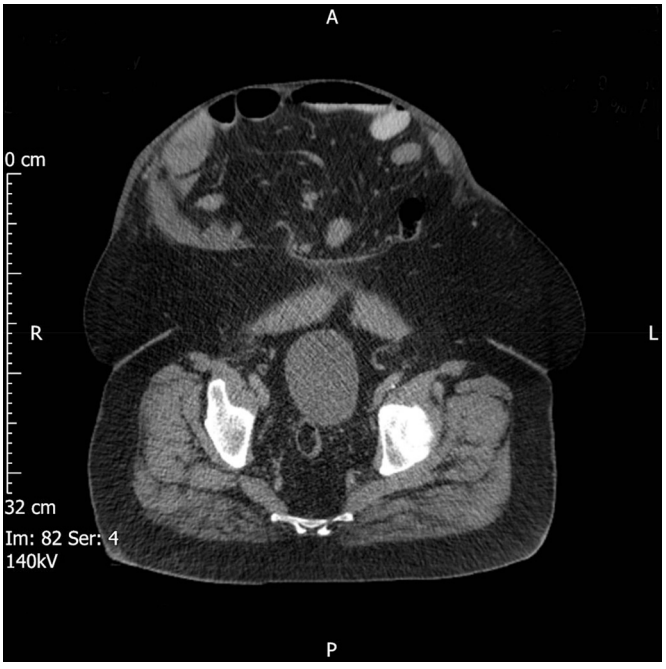

Figure 2. Image Abdominal CT scan patient with hernia.